

Appendix A. 1992 Yellowstone National Park Wildland Fire Management Plan.

YELLOWSTONE NATIONAL PARK WILDLAND FIRE MANAGEMENT PLAN

*Prepared by
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March 1992

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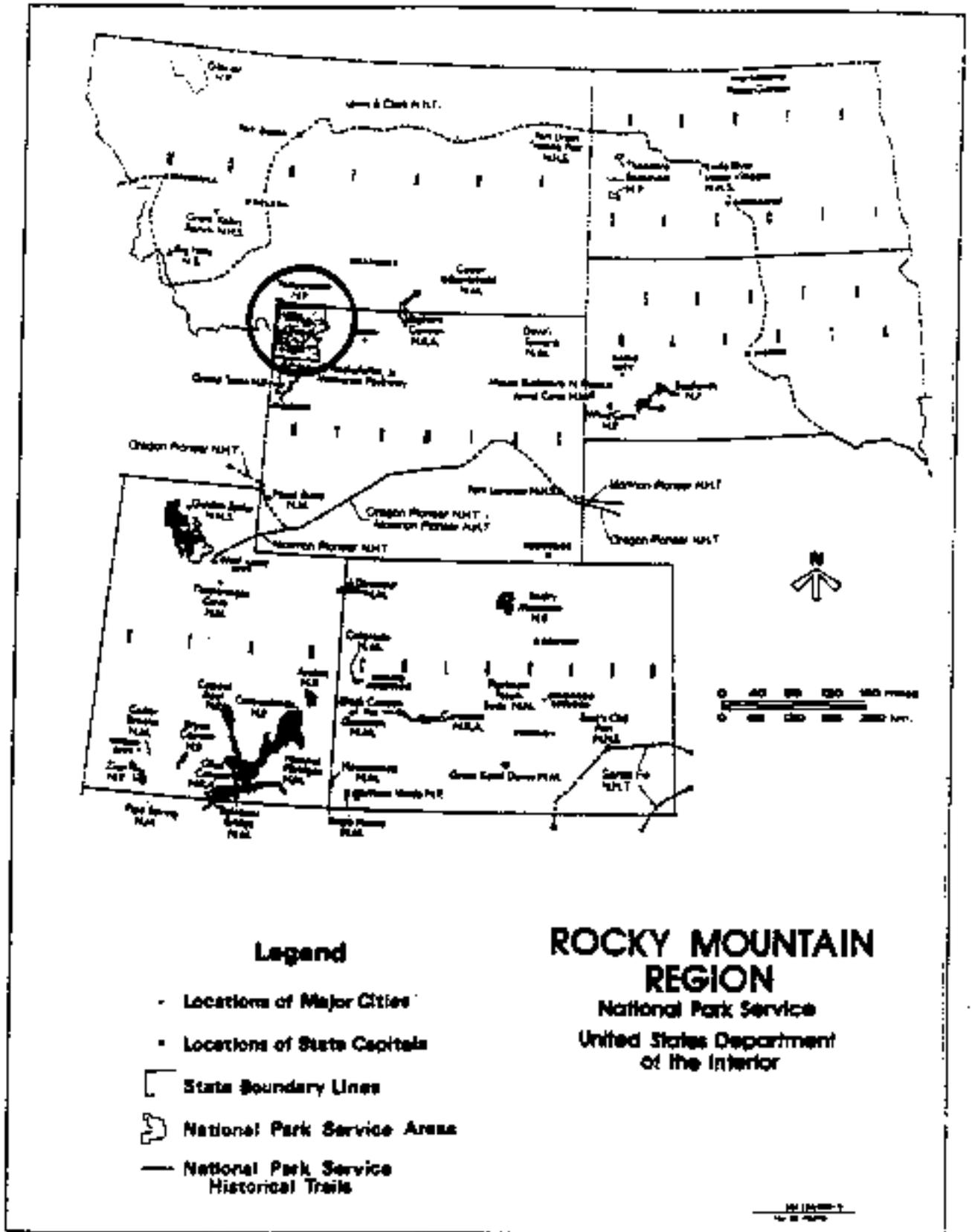


Figure 1: Rocky Mountain Region - National Park Service

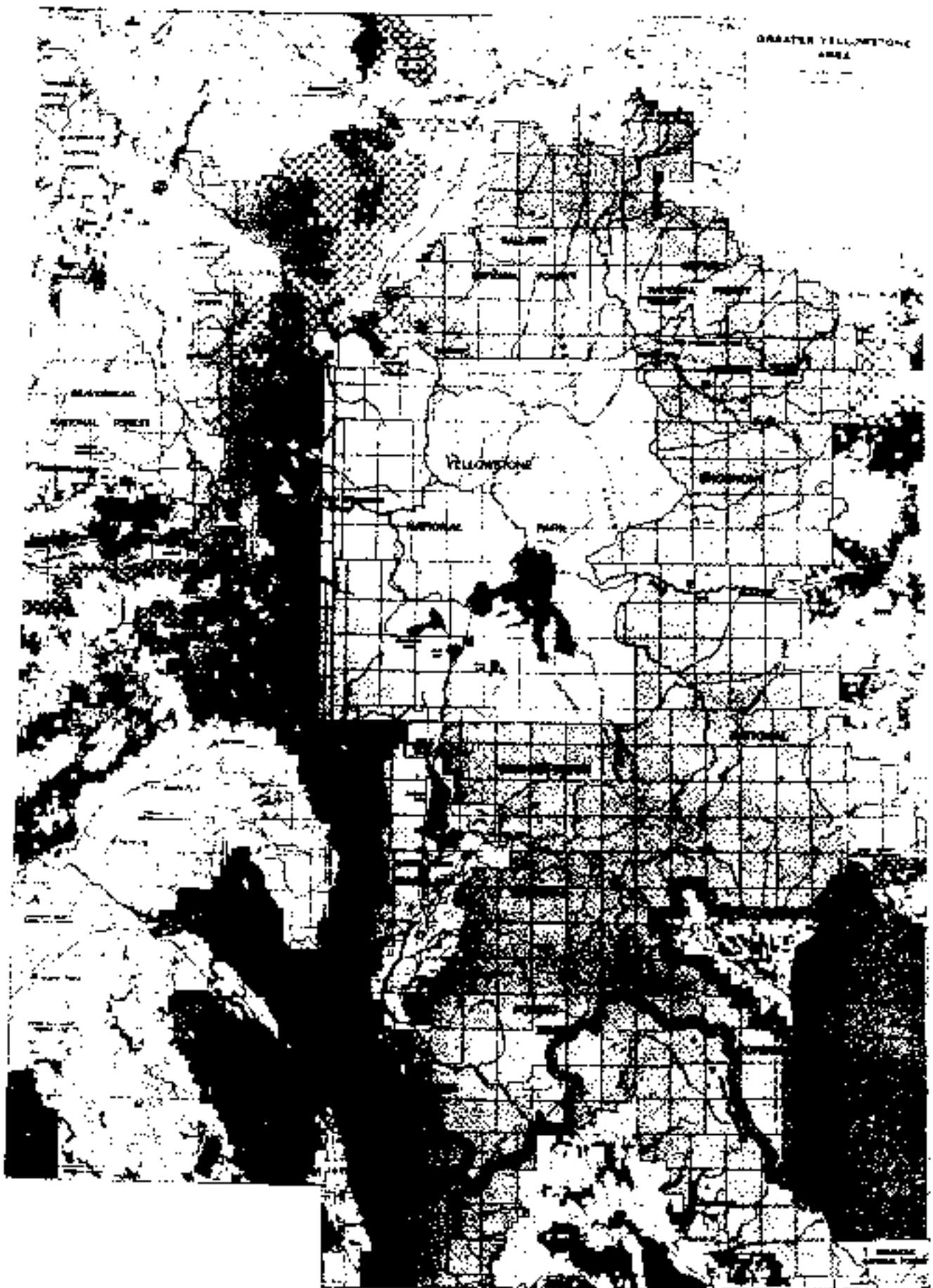


Figure 2: Greater Yellowstone Area

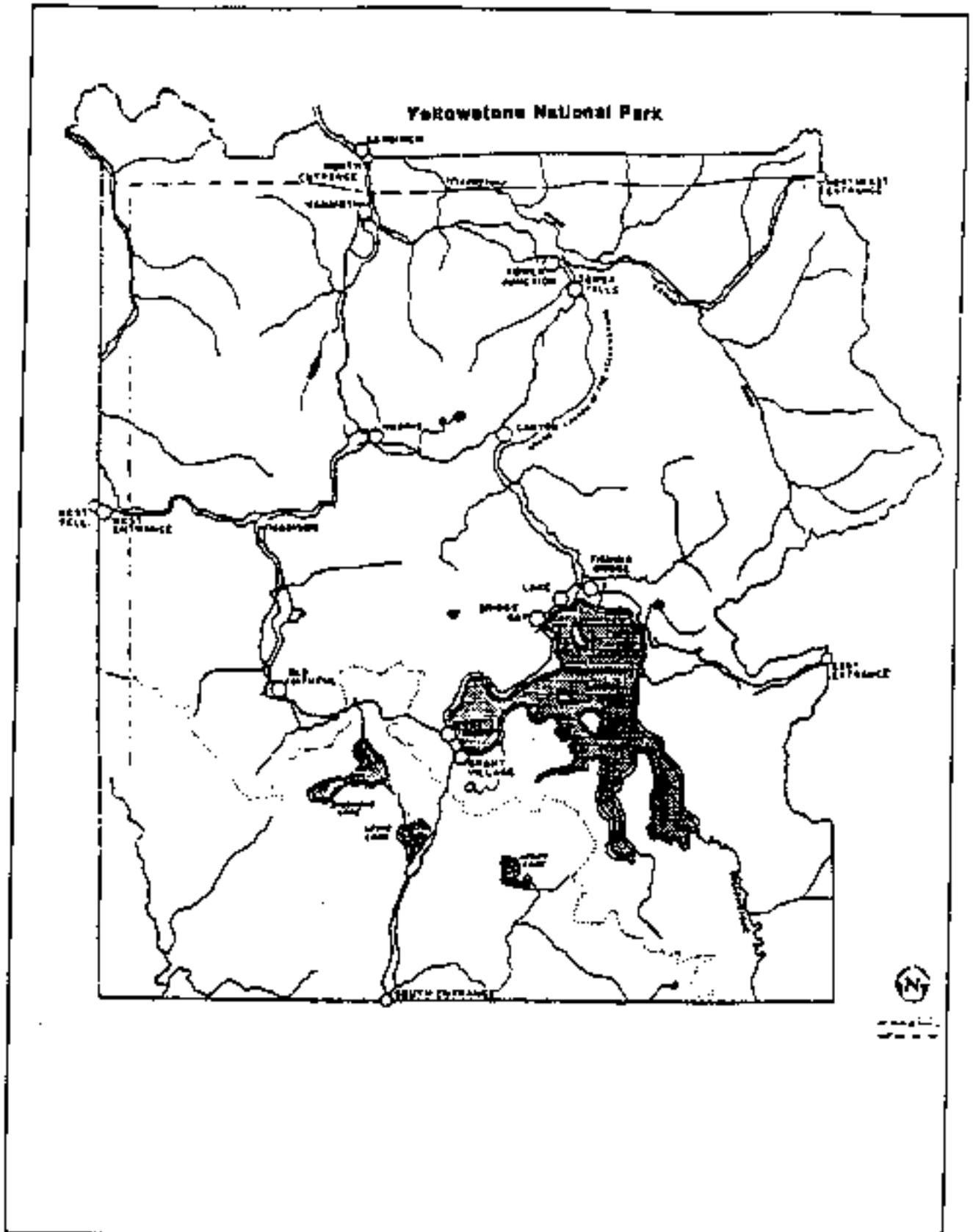


Figure 3: Yellowstone National Park

I. INTRODUCTION

A. Purpose of the Wildland Fire Management Plan

The Wildland Fire Management Plan is a detailed program of action that provides specific procedures for accomplishing park management objectives. The implementation of this plan will allow fire to play its ecological role in the park while protecting human life, developments, and cultural resources. The plan includes specific fire prescriptions, incorporates the use of management-ignited prescribed fire in predetermined areas, and suppresses all fires declared wildfires. Fire is an active and powerful natural force which has the potential to affect all areas of the park and many facets of park management at various times and to varying degrees. To successfully manage a complex fire program and meet resource management objectives, Yellowstone has developed this plan.

B. Environmental Compliance

The Environmental Assessment that accompanies this Wildland Fire Management Plan describes and analyzes the potential environmental effects of the proposal and three alternatives. It was prepared in compliance with the requirements of the National Environmental Policy Act and Section 7 of the Endangered Species Act. Consultation with the U.S. Fish and Wildlife Service was conducted concurrent with public review of the Wildland Fire Management Plan and Environmental Assessment. Additionally, the state Historic Preservation Offices for the states of Idaho, Montana, and Wyoming were consulted.

C. Authority for Implementation of the Wildland Fire Management Plan

The authority for implementing wildland fire management plans is found in the National Park Service (NPS) Organic Act (16 USC 1, August 25, 1916), the 1976 Authorities Act (16 USC 1a), and is further clarified in the National Parks and Recreation Act of 1978. The National Park Service Wildland Fire Management Guideline (NPS-18) summarizes the statutes which authorize the funding of suppression, presuppression, prevention, prescribed natural fire, and management-ignited prescribed fire activities, as well as rendering assistance outside of the park.

II. COMPLIANCE WITH NATIONAL PARK SERVICE POLICY

A. Enabling Legislation

The Act of March 1, 1872 (17 Stat. 32), established Yellowstone National Park as the world's first national park and laid the basic framework for the unique land-use policy embodied within the present national park system. Yellowstone was "...dedicated and set apart as a public park or pleasuring ground for the benefit and enjoyment of the people," and "...for the preservation, from injury or spoliation of all timber, mineral deposits, natural curiosities or wonders ...and their retention in their natural condition."

The Act of May 7, 1894, provided for the protection of birds and mammals within Yellowstone National Park, prohibited hunting, and regulated fishing.

The Act of March 1, 1928 (45 Stat. 1435), changed the east boundary of the park to conform more closely with natural topographic features and added lands at the northwest corner of the park that contain petrified tree deposits and elk winter range.

A Presidential Proclamation of October 20, 1932, as authorized by the Congressional Act of May 26, 1926 (44 Stat. 656), added land north of the park, known as the Gardiner Addition, which included additional wildlife winter range.

B. Resource Values to be Protected

The commanding features that initially attracted interest and led to the reservation of Yellowstone as a national park were geological: the geothermal phenomena, the colorful Grand Canyon of the Yellowstone River, the fossil forests, and the size and the elevation of Yellowstone Lake.

Approximately 60 percent of the world's fumaroles, boiling springs, and geysers are located in the park. Yellowstone Lake has a 110-mile shoreline and covers an area of 139 square miles. It has a maximum depth exceeding 390 feet and supports the largest natural cutthroat trout population in the world.

In 1972, 95 percent of Yellowstone (2.01 million acres) was proposed for designation as wilderness. Yellowstone National Park supports one of the continent's largest and most varied large mammal populations and is recognized as the largest, nearly intact ecosystem in the temperate zone.

In 1972, Yellowstone became the first American area to be designated as a Biosphere Reserve by the United Nations Educational, Social, and Cultural Organization (UNESCO). In 1978, UNESCO designated Yellowstone a World Heritage Site.

C. Role of the Fire Management Plan

National Park Service policy (NPS-18) requires that all parks with vegetation capable of sustaining fire develop a wildland fire management plan that will meet the specific resource management objectives for that park. Scientific evidence indicates that fires had been a part of Yellowstone's environment for thousands of years prior to the arrival of modern man. Fires have played a role in the formation of soil, vegetation, and wildlife patterns in Yellowstone.

D. Fire Policy History

Wildland fires in Yellowstone have been recorded since the first expeditions to the area during the years 1869 to 1872. These eyewitness accounts reported fires covering many square miles burning in various areas of the park. They also described the mosaic patterns left by earlier fires. Other

early writers and excerpts from Superintendents' reports stated that many fires were started by lightning. Most fires, however, were caused by humans. These fires resulted from campfires left unattended by park visitors, hunters attempting to drive game from the park, or abandoned Indian warming and cooking fires.

In 1872 Yellowstone National Park was established for the ". . . benefit and enjoyment of the people." In the 1870s, the interpretation of this enabling legislation was to preserve and protect park resources. Because fire was seen as a destructive force, the fire management policy for the first 100 years evolved into one of aggressively suppressing all forest fires.

In 1963 the Leopold Report (Leopold et al.) signaled a change in National Park Service attitude and policy concerning fire's role in the environment. This report suggested that natural areas in the national park system be managed to create a reasonable illusion of primitive America, and to maintain the biotic associations that prevailed when each area was first visited by white man. The report attempted to explain the important and dynamic role that natural fire plays in an ecosystem. As part of a management strategy, the changes caused by fire could improve the health of the natural environment and increase its diversity.

In 1972 Yellowstone responded to the policy changes initiated by the Leopold Report by preparing a natural fire management plan. This plan designated 340,784 acres in two backcountry regions of the park as natural fire zones: the Mirror and Two Ocean plateaus. Ten fires burned a total of 831 acres in the fire seasons of 1972, 1973, and 1974. The successful experience of these seasons led to the revision of the plan. This revised plan, including an environmental assessment prepared under the National Environmental Policy Act, expanded the Natural Fire Zone to include most of the park. Developed areas and a buffer zone around the park boundary were excluded from the Natural Fire Zone. The revised plan was approved and implemented in 1976 and remained in effect until suspended in July 1988.

III. DESCRIPTION OF AREA

A. General

Yellowstone National Park encompasses 2,221,772 acres (3,472 square miles) and is located primarily in the northwest corner of Wyoming, with portions extending into southwestern Montana and southeastern Idaho. The park lies within Wyoming's Teton and Park counties, Montana's Park and Gallatin counties, and Idaho's Fremont County. Adjacent and near to the park are the gateway communities of West Yellowstone, Gardiner, Cooke City, and Silver Gate, Montana, and Cody, Dubois, and Jackson, Wyoming.

Land ownership around the Yellowstone is primarily under the jurisdiction of the U.S. Forest Service and the National Park Service. The national forests are the Gallatin, Targhee, Bridger-Teton, Shoshone, Custer, and Beaverhead. The park units include Grand Teton National Park and John D. Rockefeller, Jr., Memorial Parkway. A few small parcels of land owned by the state of Montana border the park. A few privately-owned properties also border the park. The Royal Teton Ranch, owned by the Church Universal and Triumphant, is the largest private landowner. This ranch is located along the north boundary of the park, west of Gardiner, Montana.

B. Natural Resources

Yellowstone occupies a large mountainous plateau in the northern Rocky Mountains. Elevations range from 5,200 feet to over 11,000 feet. The park is characterized by several broad, forested volcanic plateaus surrounded by the Absaroka Mountain Range on the east, the Gallatin Mountain Range on the north, and the Red Mountains on the south. Lakes such as Yellowstone, Shoshone, Lewis, and Heart are prominent features in the park as are the Yellowstone, Snake, Lewis, Madison, Gibbon, Firehole, Gardner, and Lamar rivers. Water covers 101,235 acres of the park, or approximately 4 percent of the total area.

Yellowstone contains the world's largest and most active geothermal areas, a main reason for the establishment of Yellowstone National Park. Approximately 120 thermal areas in seven major basins that cover 25,792 acres have been identified. These areas include geysers, hot springs, mud pots, and fumaroles.

C. Climate

Yellowstone's climate can be divided into four distinct seasons. Winter is characterized by daily maximum temperatures dropping below freezing with snow accumulations beginning in late October. These weather conditions usually last into late March or early April. Spring is characterized by melting snow, cool to cold nights, and cool to warm days beginning in early April and lasting through June. Summer lasts through August and is characterized by warm days, frequent thunderstorms, and infrequent freezing nighttime temperatures. In September, freezing nighttime temperatures and warm to cool days signal the beginning of a brief fall.

There are two major climatic types in Yellowstone: valley and mountain. The valley type is common to large valleys and central plateaus and is similar to that of the Great Plains with peak precipitation falling as rain in May and June. The mountain type occurs along the Continental Divide and at higher elevations throughout the park. The mountain climatic type is characterized by precipitation falling primarily during the winter months.

D. Vegetation

Yellowstone's mountains and high plateaus are generally covered by coniferous forests or moist meadows. Following the retreat of the last glacial period, about 11,000 years ago, tundra gave way

to a cold-climate coniferous forest. Whitebark pine and subalpine fir forests were eventually invaded by lodgepole pine. Most of Yellowstone's present forests became established between 1450-1860 and show past evidence of extensive fires. The Yellowstone and Lamar river valleys are covered by dry grasslands and sagebrush steppe communities with Douglas-fir found on the north-facing slopes.

Vegetation covers 95 percent of the park; of which 81 percent is forested. The forested areas are dominated by seven coniferous species, while sagebrush and grasslands cover 14 percent of the park. Lodgepole pine covers approximately 1,802,841 acres or 76.5 percent of the forested area, while whitebark pine covers 218,684 acres (12.1 percent), Douglas-fir covers 104,276 acres (5.8 percent), and spruce/fir covers 100,075 acres (5.6 percent).

E. Wildlife

Yellowstone is home to one of the largest concentrations of large and small mammals in the lower 48 states. Fifty-eight species of mammals occur in the park, including seven species of ungulates and two species of bear. There are 279 species of birds, 18 species of fish, 5 species of reptiles, and 4 species of amphibians. Included on this list are black bear, elk, bison, moose, mule deer, pronghorn antelope, bighorn sheep, coyote, snowshoe hare, porcupine, red fox, marten, weasel, marmot, pocket gopher, squirrel, beaver, mountain lion, golden eagle, Canada goose, double-crested cormorant, sandhill crane, black-billed magpie, various gulls and ducks, sagebrush lizard, and cutthroat trout.

Several species are protected by the federal Endangered Species Act. These species include the endangered peregrine falcon (*Falco peregrinus*), bald eagle (*Haliaeetus leucocephalus*), and whooping crane (*Grus americana*), and the threatened grizzly bear (*Ursus arctos horribilis*). Comprehensive programs offer strategies to preserve healthy populations and minimize adverse interactions with human activities for each of these species. There are no federally-listed threatened or endangered plant species in Yellowstone. See the accompanying Environmental Assessment for a detailed description of threatened and endangered species.

F. Air and Water Quality

The quality of Yellowstone's air and water is considered nearly pristine. The park is designated a Class I airshed under the federal Clean Air Act, which means Yellowstone is charged with protecting air quality values, including visibility, and ensuring that the airshed is not degraded by external activity. Streams and lakes are also designated as Class I by the state of Wyoming, primarily for the purposes of wastewater discharge.

G. Cultural Resources

For at least 10,000 years, Native Americans occupied the greater Yellowstone area. Currently, archeological evidence indicates that the majority of the use occurred seasonally. Historically, the Crow, Shoshone, Bannock, Nez Perce, Blackfeet, and Gros Ventre were known to have visited the park (Cultural Sites Inventory for Yellowstone National Park, Midwest Archeological Center 1990). Archeological and historic evidence indicates that one group of Shoshone known as the Sheepeaters occupied portions of Yellowstone year-round during the first half of the nineteenth century. Further archeological research may show that other prehistoric and historic Native American groups occupied the park year-round as well. A number of archeological sites provide evidence of the Native American presence in Yellowstone National Park. These sites include hearths, game drives, base camps, chipping stations, rock shelters, wickiups, and teepee rings, among others.

Less than 10 percent of Yellowstone's 2.2 million acres have received any kind of archeological survey. As a result of the surveys, approximately 550 prehistoric and historic archeological sites have been recorded. Included within the historic archeological sites are those of Euro-American

origin. The majority of the archeological sites have not been evaluated for eligibility to the National Register of Historic Places. One of the few sites that has been evaluated for eligibility to the National Register is Obsidian Cliff, a prehistoric quarry site. It was determined to be so significant that the process of nominating it as a National Historic Landmark has been initiated.

The ethnographic record for Yellowstone National Park is incomplete. The cultural resources component of the Resource Management Plan will identify the need to develop an ethnographic overview and assessment. What little is known indicates that some "Native American myths and ethnohistoric reconstructions regard Yellowstone Lake and the immediate vicinity as ethnic homelands." (Finalized Archeological Work Plans for Yellowstone National Park, Rocky Mountain Region, 1991). The Kiowans, Apacheans, and Shoshoneans are three of the Native American groups having a mythological/ethnohistorical connection with Yellowstone.

Yellowstone National Park was established in 1872, becoming the world's first national park. The administration of the park was initially civilian (1872-1886), then military (1886-1916), and then National Park Service (1916-present). Today, a number of historic sites and structures represent the three types of administration. The majority of the historic structures are associated with the military and National Park Service administrations and the development of concessions within the park. Many of the buildings, bridges, and other structures built by the military, National Park Service, and park concessioners represent the rustic style of architecture. Stonework, massive timbers, and decorative woodwork were used to make buildings compatible with the natural setting.

Yellowstone has 952 historic structures on the List of Classified Structures (LCS); of these, 553 are determined to be eligible to or are listed on the National Register of Historic Places. The remaining 399 structures still need to be evaluated for eligibility to the National Register. Five historic structures have been designated as National Historic Landmarks. These include the museums at Madison, Norris, and Fishing Bridge; the Northeast Entrance Station; and the Old Faithful Inn. The majority of Yellowstone's historic structures are located within six historic districts and other developed areas. Some of the structures, though, are located outside of the historic districts and developed areas. Examples of these structures include backcountry cabins, fire towers, and interpretation kiosks.

Cultural landscapes in Yellowstone National Park have not been identified. The cultural component of the Resource Management Plan will mention the need to identify potential cultural landscapes and evaluate their eligibility to the National Register of Historic Places.

Yellowstone National Park's museum collections include a diverse range of 19,000 natural and cultural objects. These include paintings, pencil sketches, Native American objects, archeological artifacts, historic objects, and a herbarium collection. Objects which are not currently in the collection but are considered significant include historical furnishings and vehicles, the photographic collection, rare books, and natural resource specimens. Yellowstone National Park's archives contain 700 linear feet of irreplaceable historical documents. The Research Library contains 8,000 reference titles and manuscripts.

H. Social and Economic Resources

The summer months of June, July, and August are the primary visitation season in Yellowstone, although the spring and fall (called the "shoulder seasons") are growing in popularity. Nearly 90 percent of visitation occurs during the summer. On peak visitation days nearly 30,000 visitors enter the park. During the last decade, park visitation has ranged from 1.9 million (1980) to 2.8 million (1990).

Surveys of Yellowstone's visitors were conducted in 1987 and 1989. In both surveys, the primary recreational activities that visitors participated in included viewing wildlife and thermal features, photography, walking, and visiting museums. Other activities reported included fishing, camping, hiking, horseback riding, and boating. These surveys document generally consistent visitor-use patterns and perceptions of fire and the landscape before and after the fires of 1988.

Yellowstone visitors come from all 50 states; however, the Rocky Mountain states, California, and Washington State each represented from 4 to 11 percent of the total park visitation. International visitation represents approximately 7 percent of total park visitation.

Yellowstone National Park is a prominent feature in the social and economic life of the surrounding area. The popularity of recreation and tourism in the area make the communities in the greater Yellowstone area heavily dependent upon federally-managed lands. These communities and their businesses receive significant income by providing goods and services to park visitors. Local businesses also benefit from annual National Park Service and concessioner expenditures for salaries, goods, and services. Short-term benefits result from periodic capital-improvement projects.

IV. FIRE MANAGEMENT POLICY

A. Agency Policy

National Park Service management policy directs each park to prepare a wildland fire management plan that is appropriate for that park's purpose and resources. Fire management in Yellowstone is based upon this policy and the revisions found in NPS-18 (revised June 1990). This guideline identifies fire as the most aggressive natural resources management tool employed by the National Park Service. The guideline also states that all wildland fires are classified as either prescribed fires or wildfires. Prescribed fires, naturally-ignited or management-ignited, may be authorized by an approved wildland fire management plan and contribute to a park's resource management objectives. Wildfires are unplanned events and may not be used to achieve resource management objectives.

NPS-18 identifies three paramount considerations that should be addressed by each park's fire management program. They are:

1. The protection of human life, both employee and public.
2. The protection of facilities and cultural resources.
3. The perpetuation of natural resources and their associated processes.

B. Park Policy

Yellowstone National Park further interprets NPS-18 through Yellowstone's Master Plan (1974), Resource Management Plan (1983), Statement For Management (1991), and other approved documents. Specifically, these documents state the park's objectives for wildland fire management as follows:

1. To protect human life, property, and designated resources.
2. To allow fire to play its ecological role in the park to the greatest extent possible through the use of appropriate management techniques.
3. To suppress wildfires in a safe, cost-effective, and environmentally sensitive manner commensurate with the values at risk.
4. To maintain an active fire prevention program.
5. To maintain a fully qualified fire management staff to implement the fire management plan.
6. To maintain an interpretive and public information program that will educate the public on the ecological role of fire in the park and provide daily fire danger and situation information.

V. FIRE MANAGEMENT STRATEGIES

This Wildland Fire Management Plan identifies three integrated strategies to direct wildland fire management in Yellowstone: suppression, management-ignited prescribed fire, and prescribed natural fire.

A. Suppression:

This strategy includes all actions initiated to limit the growth of a wildfire. A "wildfire" is defined as a free burning and unwanted fire requiring suppression action. Wildfires will always be suppressed. There are three suppression options which allow the fire manager to suppress wildfires at minimum cost and minimum impact to park resources. They are confine, contain, and control. Wildfires will be suppressed in the safest and most cost-effective manner possible.

B. Management-ignited Prescribed Fire:

Management-ignited prescribed fires are fires intentionally ignited to accomplish management objectives as determined by an annual hazard fuel analysis program report. The goal is to reduce the wildfire threat to human life and to protect facilities both inside the park and adjacent to the park boundary. Escaped prescribed fires will be declared wildfires, and the appropriate suppression response will be initiated.

C. Prescribed Natural Fire:

Prescribed natural fires are fires ignited by natural means (usually lightning) that are permitted to burn under specific environmental conditions. The objective of prescribed natural fire is to perpetuate natural processes. Each natural fire is allowed to continue burning as long as it remains within prescription. Fires that exceed these prescription limits will be declared wildfires, and the appropriate suppression response will be initiated.

VI. FIRE MANAGEMENT SITUATION

A. Fire Management Zones

The Wildland Fire Management Plan divides Yellowstone into three management zones: Suppression, Conditional, and Prescribed Natural Fire. These zones are established for different purposes. In the Suppression Zone personal safety and protection of property is of primary importance. In the Conditional Zone the dual purposes of allowing prescribed natural fires to burn within certain prescriptions and the protection of life and property within and outside park boundaries from unwanted fire are balanced. In the Prescribed Natural Fire Zone naturally-ignited fire is allowed to play its ecological role in the park (see Figure 4).

Suppression Zone

Description: Within the Suppression Zone, fire management activities will ensure the maximum protection for personal safety, property, and specific cultural resources. All fires that originate in or burn into this zone, despite their cause, will be immediately suppressed. Hazard fuel reduction may be undertaken by management-ignited prescribed fire and mechanical methods.

Area: This zone includes all major developed areas in the park. The zone around each area includes a one-half (0.5) mile buffer on the windward (southwest) side and a one-quarter (0.25) mile buffer in all other directions (see Figure 4).

The developed areas encompass approximately 2,200 structures and 38 recreational sites. These developed areas include: Mammoth Hot Springs, Tower Junction, Lamar Ranger Station, Northeast Entrance, Norris, Madison, Canyon, Fishing Bridge, Lake, Old Faithful, Grant Village, South Entrance, East Entrance, West Entrance, and Bechler Ranger Station.

Conditional Zone

Description: The cause of each fire that starts in the Conditional Zone will be determined in order to initiate the appropriate fire management response. This will ensure the protection of personal safety, property, and other specific cultural resources. Prescribed natural fires will be allowed to burn within predetermined prescriptions. Prescribed natural fires will be allowed to burn in this zone under more conservative prescriptions than applied in the Prescribed Natural Fire Zone. Each prescribed natural fire will be monitored daily to ensure that it will remain within prescription. Any fire predicted to exceed prescription or that has exceeded prescription, will be declared a wildfire and the appropriate suppression response will be taken. Hazard fuel reduction may take place in this zone with the objective of reducing fuel accumulations, breaking up continuous fuels, and reducing the threat of unwanted fire. This may be accomplished by either mechanical or physical treatments or management-ignited prescribed fire.

Prescribed natural fires will be allowed to burn across agency boundaries in this zone if all provisions of the Greater Yellowstone Area Memorandum of Understanding are met (see Appendix E). The agency receiving the fire must have an approved and operational prescribed natural fire plan. A joint prescribed natural fire burn plan will be completed by all agencies involved. Decision criteria for daily revalidation of the burn plan (which will allow a fire to continue burning as a prescribed natural fire) will be signed by the appropriate line officers of each involved agency.

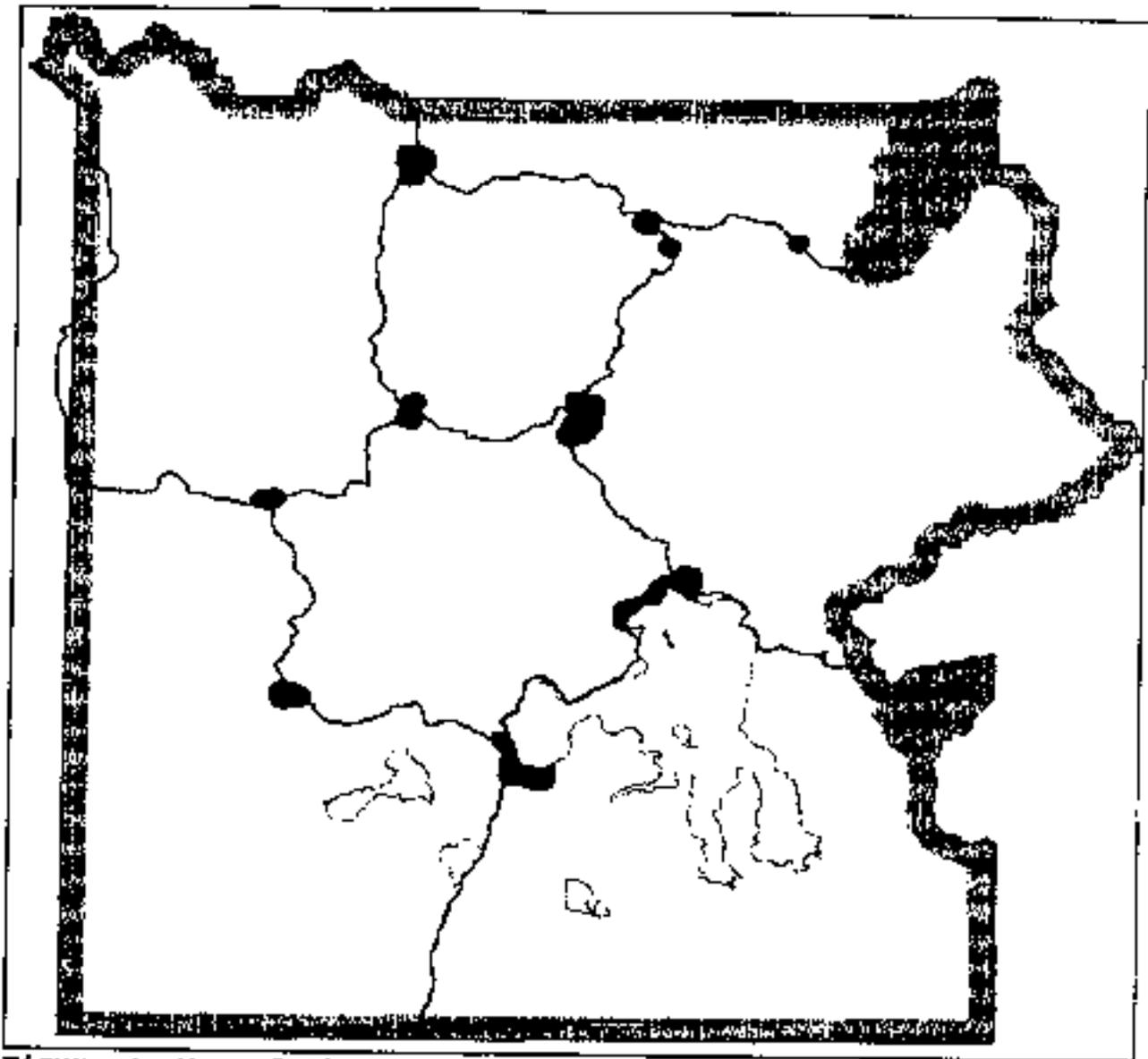


Figure 4: Map of Fire Management Zones

Area: The Conditional Zone includes the area from the park boundary to one and one-half (1.5) miles inside that boundary, including the Soda Butte drainage from its confluence with the Lamar River to the Northeast Entrance and the Middle Creek Fork drainage of the Shoshone River located inside the park's east boundary. Improvements located outside of major developed areas and included in this zone are: the smaller campgrounds, backcountry cabins, powerline corridor, picnic areas, and telephone installations. These improvements are generally located in isolated areas of the park and do not warrant the level of protection that the areas within the Suppression Zone will receive. The goal is to protect these improvements but to not create greater resource damage by suppression actions.

Prescribed Natural Fire Zone

Description: The Prescribed Natural Fire Zone includes areas within the park where naturally-ignited fires will be allowed to burn under predetermined prescriptions designed to perpetuate natural processes. The cause of all fires will be determined to ensure that they are naturally ignited; if not, appropriate management actions will be taken. All prescribed natural fires will be monitored daily and decisions revalidated to ensure that each fire will remain within prescription. A prescribed natural fire that exceeds prescription will be declared a wildfire and appropriate suppression action taken.

All human-caused fires originating within or burning into this zone will be declared wildfires and appropriate suppression action taken. Management-ignited prescribed fires may be used in this zone to meet management objectives of hazard fuel reduction around a smaller campground or a backcountry cabin.

Area: This zone encompasses the portion of the park inside the Conditional Zone, except for the designated developed areas which are part of the Suppression Zone. Improvements in this zone such as campgrounds adjacent to developed areas, backcountry cabins, the powerline corridor, picnic areas, telephone installations, and roads will receive special consideration when determining the appropriate fire management action.

B. Fire History

Archeological records show that man has occupied the Yellowstone Plateau for at least the last 10,000 years (Lahren 1971). Excavations have revealed that early humans throughout North America used fire for agriculture, food gathering, hunting, and warfare. Records from early fur trappers and expeditions to Yellowstone attribute many fires to Indians, set for hunting, warfare, and even to drive trappers out of their hiding places (Bonney and Bonney 1970).

Written fire records date back to 1870, and significant fires are noted in early annual Superintendents' reports. Fire statistics from 1872 through 1899 are very sketchy with only large fires being reported. Record keeping improved somewhat at the turn-of-the-century. From 1900 through 1929 approximately 374 fires burned 11,670 acres.

Reliable fire statistics have been

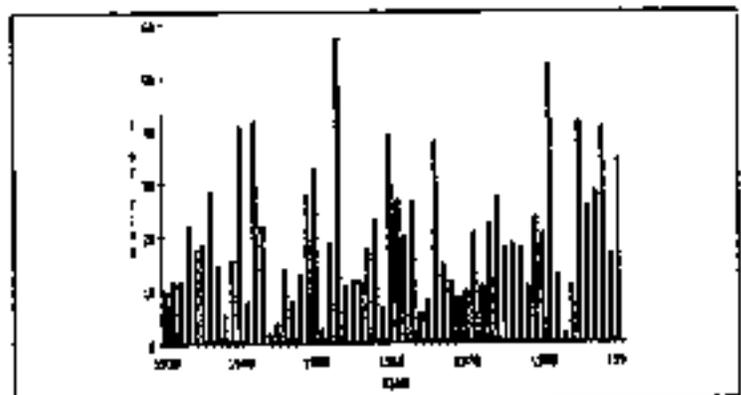


Figure 5: Lightning Fire Occurrence

kept since 1930 (Figures 5, 6, 7 and 8). In the past 60 years, 1900 fires have burned 908,052 acres. Lightning-caused fires numbered 1209 (Appendix C), while 691 fires were human-caused. In the most active fire season in recorded history, 1988, 45 fires originating within Yellowstone burned approximately 301,880 acres. Five fires originated outside Yellowstone and burned approximately 492,000 acres within the park. Combined, a total of 793,880 acres were burned. The largest of these fires, the North Fork fire, burned a total of 406,359 acres. It was human-caused and began on the Targhee National Forest.

Three fire history studies have been conducted in Yellowstone. One study concentrated on the sagebrush and grasslands of the northern range (Houston 1973). Another study was conducted on the Little Firehole River watershed (Romme 1979). A third study reconstructed the fire history of a 320,000 acre study area located on the subalpine plateaus in the south-central part of the park (Romme and Despain 1989). Currently a fire history study is under way in the upper Lamar River drainage (Arno and Barrett). Fire history studies have also been conducted in Montana and Alberta, Canada (Arno 1980), in similar fuel types. All studies support the conclusions that fire has had a substantial influence on plant community succession and that fire has long played an ecological role in the environment.

Houston's study (1973), on the edge of the low-elevation sagebrush steppe, sampled 34 trees with an average age of 322 years. Analysis indicated that the average return interval between fires was 53-96 years, with mean intervals for individual trees ranging from 36-108 years. The mean adjusted fire interval for the study area was 20-25 years, with eight to ten large fires burning significant acreage over the past 300 to 400 years (see Figure 9). Fire suppression efforts from 1886 until 1972 were almost completely successful on the sagebrush steppe of the northern range. The largest fire on the northern range prior to 1988 burned approximately 460 acres.

The fire history studies summarized by Arno (1980) for the subalpine forests of Montana and Alberta reported fire frequencies ranging from 63 to 153 years. Romme and Despain's (1989) study of 320,000 acres in Yellowstone's subalpine forests showed fire frequencies of approximately 300 to 400 years. This study also reported that less than 10 percent of the watershed had burned in the

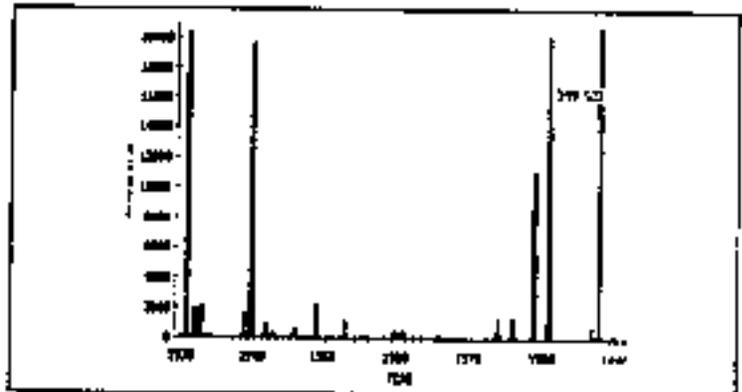


Figure 6: Acreage by Lightning-Caused Fires

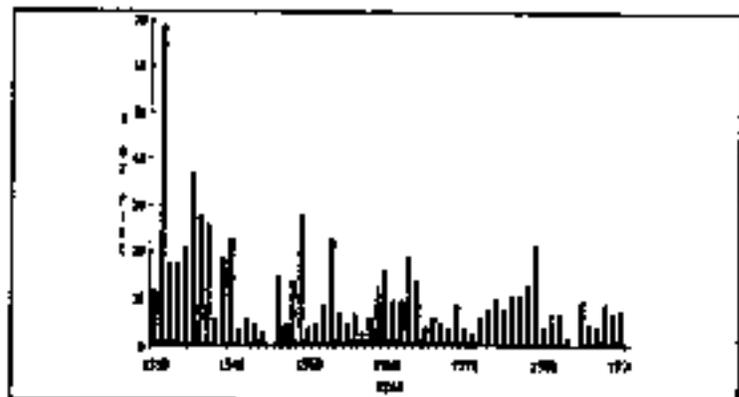


Figure 7: Human caused Fire Occurrence

previous 350 years. The study concluded that most of the study area was an even-aged stand and had last burned between 1690 and 1740.

An analysis of these two studies suggests that a principal reason for the differences between the fire frequency estimates is fuel accumulation. Romme and Despain's study area in Yellowstone was at a higher elevation where growing conditions are less productive, leading to less understory

growth. Additionally, Arno's study reported more areas of mountain pine beetle infestation. This would contribute to greater fuel accumulation on the forest floor thus making it possible for fires to spread through the area more frequently.

The fire history of Yellowstone has been influenced by man and by man's fire suppression efforts. Romme and Despain (1989) evaluated Yellowstone's fire history in light of the 1988 fires (see Figure 9). They suggested that fire suppression efforts since 1886 may have only postponed the fires of 1988 by a few decades. They noted that large fires might have occurred during the dry summers of 1949, 1953, 1960, or 1961 without fire suppression efforts. They further noted that fire behavior in terms of heat release, flame height, and rate of spread were probably similar to the fires that burned a significant percentage of their study area around 1700 (see Figure 8). They concluded that the 1988 fires represented a nearly natural event. The fires were mainly the result of extremely warm, dry, and windy weather combined with an extensive forest cover of highly flammable fuels, mainly lodgepole pine. This lodgepole pine forest was established following extensive fires around 1700 which burned a significant portion of Yellowstone (Figure 9).

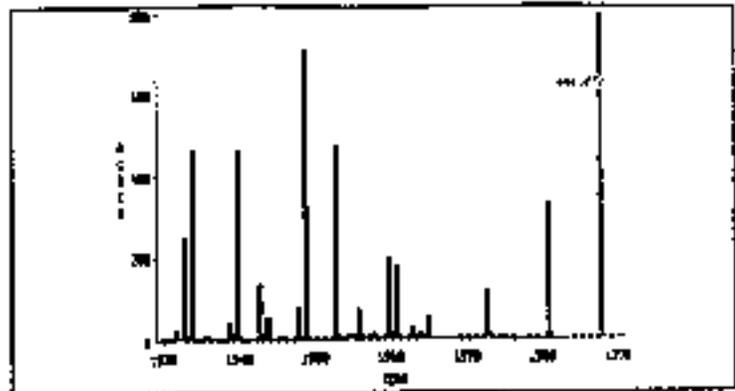


Figure 8: Acreage by Human-Caused Fires

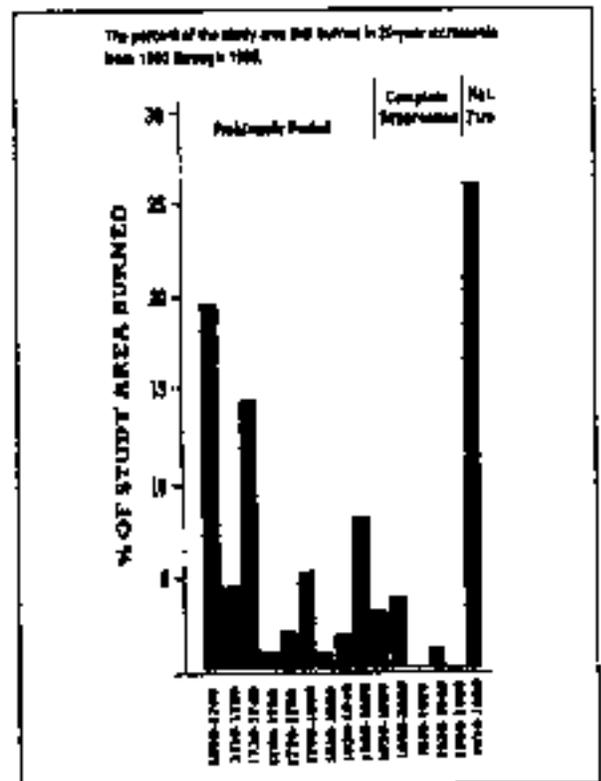


Figure 9: Fire History

C. Fire Effects

1. Vegetation

Fire has been an important factor in Yellowstone's environment whenever vegetation has covered the ground. Fire is one of the major environmental factors influencing the relationships between the

various forms of life and their environment. The plants and animals that inhabit the park have adapted to the effects of fire. The ability to sustain life is improved by fire in many habitats. In nearly all forms of life, the number of species is highest in post-burn forest communities just before the tree crowns grow together and completely shade the forest floor. Fires that burned before Yellowstone was established created a mosaic of forests in various stages of regrowth. This mosaic is an important part of the Yellowstone landscape and is vital to the preservation of the natural qualities of the park.

Plant species are adapted to fire in many ways. Species that reproduce by either seed or vegetative means can better survive disturbance, including fire. The serotinous cones of lodgepole pine are an example of a specific adaptation to fire. The windblown seeds of Engelmann spruce and subalpine fir as well as the habit of the Clark's nutcracker, which caches whitebark pine seeds, are also mechanisms that reintroduce plants to a burned area. Research following the 1988 fires (Clark et al. 1990) has shown that a great number of seeds from numerous plant species survived the fires in the soil. Other studies (Despain 1990) have found that within a year these seeds, along with rhizomes, bulbs, root crowns, and other reproductive structures, provide a highly variable plant cover on the burned sites.

Mineral nutrients are vitally important to plants, and an initial increase in plant nutrients following a fire may last up to four years. A corresponding increase in plant productivity may last for a longer period, depending upon the species (Christensen 1988). Following a fire, there is also an abundant supply of soluble minerals which are absorbed and increase plant growth (Despain 1972). The effects of fire on vegetation are highly dependant upon the environmental conditions and the plant community that existed on the site before fire. In grassland fuel types, fire stimulates flowering in many species, such as lupine, and production of vigorous new leaves in many grasses. Small areas beneath sagebrush plants can burn sufficiently to kill all plants and seeds, providing seedbeds for neighboring plants. Open areas occur in forested communities where deep accumulations of organic matter burn during a fire. These sites are places for seedling establishment. In sites where soil nutrients are favorable and water is readily available, the plant community is abundant and diverse. When these communities burn, revegetation occurs quickly. In sites where growing conditions are poor and the plant community is sparse, the post-burn vegetation is scattered and slow in covering the ground.

Fire intensity may also effect the vegetative response to fire. Where soil and duff moisture content is high, there is little effect on the vegetation other than killing the above-ground trees or shrubs. When soil and duff moisture content is low, the above-ground plants as well as seeds and rhizomes in the upper soil layer can be killed. The vegetation must then regrow from seeds and plant parts found deeper in the soil. Fire intensity can therefore add to the overall mosaic pattern of the park's plant communities.

2. Wildlife

2. Large Mammals

The indirect effects of fire on large mammals are more significant than direct mortalities due to fire. Large mammals and their forage species in Yellowstone evolved in the presence of fire. Fire effects tend to be positive for ungulates in the long-term. Short-term displacement does occur during a fire, but animals soon return to the burned areas and resume grazing after the fire's passage. Wildlife often responds favorably following fire due to changes in plant succession; increased production of grasses, forbs, and shrubs; higher protein and lower fiber content in forages; earlier spring greenup; and the availability of a more diverse diet (Singer, et.al. 1989).

Direct effects of fire on faunal populations vary greatly. Vertebrates are rarely killed in fires; where death does occur, the number is usually small. The numbers of invertebrates may decrease initially; however, certain species that are attracted by heat, smoke, or damaged trees may increase during or after a fire. The post-fire environment results in a sudden change of habitat structure and local microclimate which will have varying influences depending upon the species (USDA GTR WO-6 1978).

Fire effects data for grizzly bears gathered during 1988 indicated that of 21 radio-monitored grizzly bears in the Greater Yellowstone Area (GYA), 13 moved into burned areas after the fire front passed, 3 remained within active burns, 3 stayed outside the burn perimeters, and 2 were not accounted for. The fires did not affect choice of den sites, annual range sizes, or mean rates of movement. The immediate effect of the fires was an increased food source in the form of ungulate carcasses (Blanchard and Knight 1989).

b. Birds

Fires are instrumental in increasing vegetative structural diversity through mosaic burn patterns and edge effect. This, in turn, improves bird diversity, an important factor affecting bird populations in coniferous forests. Bird densities vary with the age and structure of the forest stands. Brooding bird densities increase in young forests, suggesting that periodic burning of lodgepole pine forests promotes greater biotic diversity (Taylor 1973). Bird species belonging to the bark-foraging guild increase in numbers for the first few years following fire due to an increase in insect populations attracted to areas with fire-killed trees.

Old-growth forests support unique species of birds that have extremely narrow habitat requirements. Fire may have a negative impact on birds dependent upon old-growth forests by eliminating a niche for a particular species. These species may be displaced to other areas that have old-growth forests. These species may eventually return to previously burned areas in larger numbers as the stand ages.

c. Fisheries

The effects of fire on aquatic ecosystems and fisheries can be classified as immediate, intermediate, and long-term. Immediate effects can include raised water temperatures, pH, and alkalinity, as well as problems associated with suppression efforts, such as fire retardant accidentally entering a lake or stream. Previous observations show that fire retardant can cause stress or death to aquatic organisms including fish in localized areas (Mills 1989). The effects of fire are generally greater in headwater streams and progressively decrease with increased stream size (Minshall et al. 1989).

Intermediate effects are less disruptive. Increased sediment levels, turbidity, and erosion of stream channels can be expected in some watersheds. In some circumstances pools may fill with sediments, but this is generally offset by the increase in large woody debris which creates new pools. Dramatic influences on water chemistry are generally prevented since chemicals become diluted; are absorbed by plants; or bind to soil, roots, and debris. After extensive fires nutrient output will increase because the terrestrial plant absorption rate will be reduced and there will be increased mineralization and leaching of elements accumulated in the watershed (Minshall et al. 1989). It is likely that slight increases in water temperatures will occur (Albin 1979) which, when coupled with increases in light (due to overstory removal) and nutrients, will increase primary and secondary production, including growth of algae and aquatic vascular plants, invertebrates, and fish (Minshall et al. 1989).

Most of the long-term aquatic responses to fire will be closely allied with the recovery of the

forest and understory vegetation. Eventually, recovery of the forest cover should result in increased shading of the streams, decreased runoff and nutrient input, and the return of the streams to their prefire state. Factors that regulate forest succession in the Yellowstone area, such as soil and geologic type, elevation, and climate, cause streams and fisheries to differ in their long-term responses to disturbance from wildfire (Minshall et al. 1989).

Overall, the impacts of fires on fish populations and fisheries are expected to be minimal and short-term (Varley 1989).

3. Water Quality

Large fires have the potential to increase the total water yield from a drainage and cause the peak runoff to occur earlier in the spring. Removal of vegetation by fire can enhance the possibility that erosion would increase for one to five years following a fire. Rapid snowmelt and summer thunderstorm events may intensify these natural erosion processes. Increased sedimentation may occur in the short-term (one to five years) and may alter the prefire aquatic conditions enough to change the ecological and successional state in ponds, lakes, and streams (Christensen et al. 1989, Minshall 1989).

Reduced shading that results from fire can increase stream and lake temperatures for many years. In a subalpine environment such as Yellowstone, this can increase the pace of physiological and ecological processes and lengthen the growing season. Nutrient availability increases for an indeterminate period of years and can increase aquatic plant response, which may translate into an increased invertebrate and vertebrate response (Albin 1979, Christensen et al. 1989, Minshall 1989).

Although the immediate effects of fire can be disruptive to streams and lakes, intermediate and long-term fire effects on streams and lakes will be minimal and of short duration (Christensen et al. 1989, Varley 1989).

4. Soil

Extensive postfire studies (including studies from the 1988 fires), mapping of burn intensity, and soil sampling at hundreds of locations over the Yellowstone Plateau have shown that most fires heated the soil to only light or moderate intensity. Less than one-tenth of 1 percent of soils in the area were heated to an intensity that penetrated more than two inches deep and consequently kill seeds, roots, bulbs, rhizomes, and other plant tissues necessary for regeneration. In certain areas, steep topography and canyon 'chimneys' can cause the percentage of high intensity or severe burn to be as high as 10 to 15 percent. Generally, severe heating only occurs beneath large fallen logs, in deep duff, and where dead and dry roots are consumed by fire. Soils that are burned at this intensity have all of the organic matter volatilized, and an external seed source is required to restore vegetation. Soil heating can also cause short-term changes in water infiltration potential and an increase in water repellency, which may result in increased runoff and possible erosion events if rapid snowmelt or intense summer thunderstorms occur (Christensen 1988, Mills 1989).

Nutrient availability from ash may increase soil fertility for a few years immediately following a fire. This may be favorable for many species of plants, nitrogen-fixing microbes, and nitrifying bacteria. Soil and microclimatic conditions following a fire also favor establishment and growth of native herbaceous and shrub species that may be important in replenishing nitrogen lost during burning (Christensen 1988, Christensen et al. 1989).

Soils in burned areas tend to warm up sooner in the spring and reach higher temperatures than soils covered by vegetation. For some years following a fire, these warmer temperatures increase soil microbial activity and extend the growing season. In the Yellowstone ecosystem these factors, plus

the increased availability of nutrients, are directly responsible for increased plant production following fires (Christensen 1988).

5. Air Quality

Smoke and the chemicals produced by forest fires have a variety of effects upon air quality. The primary products of combustion of organic materials include carbon dioxide, water vapor, carbon monoxide, particulate matter, hydrocarbons, nitrogen oxides, and trace minerals. In addition to the compounds considered pollutants in smoke, forest fire smoke also contains and distributes elements, compounds, and minerals considered to be "biological building blocks" necessary for the creation and production of plant tissues. Nutrients that were previously stored in vegetative or woody matter, such as carbon, phosphorus, nitrogen, calcium, and potassium, while mostly released as ash, are also carried in smoke and fall to the earth's surface over a broad geographic area. Although not widely studied, it is hypothesized that these nutrients may stimulate plant production in areas receiving the fallout from forest fires. Smoke is also known to have anti-fungal properties, but the effect of this phenomena on adjacent unburned plant communities has not been adequately researched.

Air quality standards for allowable emissions are based on health effects. These standards are intended to protect sensitive members of the population with adequate safety margins. Intense exposure and effects on humans from smoke is usually limited to firefighters suppressing forest fires or personnel conducting management-ignited prescribed fires. A more detailed discussion of air quality is located in Chapter XI of this plan: Air Quality/Smoke Management Guidelines.

D. Fire Behavior and Fuel Types

The majority of fires that occur in Yellowstone exhibit fire behavior that can be categorized under two scenarios. In the first, a fire is started when lightning strikes a snag. After ignition, the snag smolders for several days and then burns out. In the second, ladder fuels (low branches, small trees, or shrubs growing at different levels) in the understory are present, dry conditions exist, and high winds carry the fire into the overstory, which sustains an independent crown fire that rapidly increases the fire's size. Because the majority of the park is high plateau country with few natural barriers, these fires will continue to spread until the wind dies down.

Fires behave in these two ways in Yellowstone due to a lack of herbaceous and woody fuels on the forest floor that are capable of sustaining a surface fire in a normal year. In most years the fuelbed of grass and low shrubs present in the understory does not cure until the fall snows begin. Green grass and shrubs, with relatively high fuel moisture contents, inhibit the spread of fire in many understory fuel types. Fires in these fuelbeds may smolder for several days while spreading from log to log before going out during the next rain.

There are portions of the park where a dense tree understory does exist. Fires in these areas produce intensities that are hot enough to ignite seedlings and saplings in the understory and carry fire into overstory crowns. During periods of dry conditions with high winds, fires spread very rapidly through tree crowns independent of surface fire. Long-range spotting (transport of burning material by wind) of up to two miles may occur. This scenario describes how large acreages have burned in Yellowstone approximately every 250 to 300 years. These fires become "stand-replacing events" that may burn more than one million acres in a single summer.

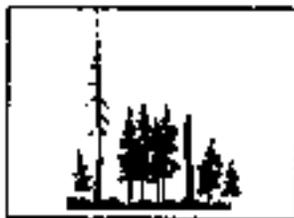
Despain (1973) has classified all the major forested cover types in Yellowstone by species and described the associated fire behavior for each cover type. Growth characteristics of each species play a significant role in fire behavior. The forests in Yellowstone are singularly lacking in shrubs; understory fuels are predominantly young trees. The description of each forest (or fuel) type and

how fire behaves in it will be discussed separately. Fire behavior characteristics will be discussed for "normal," "intense," and "extreme" situations.

1. Lodgepole Pine Fuel Types and Associated Fire Behavior

A key factor in the lodgepole pine burning cycle is the time since the last fire and subsequent development of the understory. Lodgepole pine is a self-pruning tree. As the tree grows, the crown of green branches rises higher above ground and the trunk is left devoid of branches. This sparse foliage and branching characteristic of young lodgepole pine does not provide much burnable fuel in the understory. The only substantial fine fuels are pine needles and small twigs which are located in the tree crowns in most lodgepole pine cover types. Lodgepole pine is classified into five cover types: LPO, LP1, LP2, LP3 and LP.

LOGEPOLE PINE COVER TYPES



COVER TYPE - 30 (LPO)

The LPO cover type is defined as recently burned lodgepole pine stands in the grass to seedling/sapling stage before canopy closure. These stands are approximately 0 to 40 years post-fire.



COVER TYPE - 31 (LP1)

The LP1 cover type is defined as a closed canopy of even-aged, usually dense lodgepole pine where trees are younger and shorter than those of neighboring stands. These stands are characterized as a "young pole" successional stage. A good example of an LP1 stand is found on an outwash plain at West Yellowstone, Montana, where islands of scattered short trees are next to islands of scattered larger trees. These stands are approximately 40 to 100 years post-fire.



COVER TYPE - 32 (LP2)

The LP2 cover type is defined as a closed canopy dominated by lodgepole pine. The overstory is still largely intact. Mature lodgepole pine is the successional stage. The understory is usually small to medium Engelmann spruce and subalpine fir seedlings and saplings but may also be dominated by lodgepole pine. These stands are approximately 100 to 300 years post-fire.



COVER TYPE - 33 (LP3)

The LP3 cover type is defined as having a ragged canopy of predominately old-growth lodgepole pine but also containing some Engelmann spruce, subalpine fir, and whitebark pine in the pole-size class. The stand is considered an old-growth lodgepole pine successional stage. The understory is small to large spruce and fir seedlings and saplings. These stands are three hundred plus years post-fire.



COVER TYPE - 34 (LP)

The LP cover type is defined as a canopy dominated by old-growth lodgepole pine which are beginning to break up. The understory is lodgepole pine and whitebark pine. Stands are usually found on rhyolitic soils and are multi-aged. Lodgepole pine is the climax or persistent seral species. These stands are three hundred plus years post-fire.

The most representative National Fire-Danger Rating System (NFDRS) fuel model for lodgepole pine in Yellowstone is Model G, a dense conifer stand that has a heavy accumulation of litter and downed woody material. These stands are typically old-growth stands affected by insect, disease, wind, or ice damage which creates a heavy buildup of dead material on the forest floor. The undergrowth is variable, but shrubs are usually restricted to openings. Model G reflects the conditions often found in windthrown or bug-killed stands of lodgepole pine classified as LP2 and LP3 stands - the fuel types that exhibit extreme fire behavior. Model G overpredicts fire behavior in the younger lodgepole pine stands described by LP0, LP1, and LP. These types (LP0, LP1, and LP) are best represented by Model H, which is characterized by healthy lodgepole pine stands with sparse undergrowth and a thin layer of ground fuels.

The most representative Northern Forest Fire Lab (NFFL) fire behavior model for predicting fire behavior in lodgepole pine is Model 8, closed timber litter. The fire behavior of Model 10, timber litter and understory, best represents stands where there is significant down and dead lodgepole pine logs. Fire behavior Model 12, medium logging slash, has been used successfully to predict surface fire behavior in stands of lodgepole pine with 30 tons or more per acre of down and dead material. When crowning and long-range spotting occurs, crown fire models will be used to predict fire behavior and spread.

"Normal" fire behavior conditions in lodgepole pine are characterized by periodic (average) precipitation generally received in afternoon thundershowers. Total precipitation accumulation is usually light but enough to keep fuel moistures high both for fine fuels such as grasses and pine needles and the larger down and dead logs found on the forest floor. During a normal year, Yellowstone will record 20 to 25 lightning-caused fires that will burn less than a total of five acres. Often, each fire involves a single snag and is detected by lookouts. These fires are most often extinguished by rain from the same storm system that started them. These fires have little resistance to control, are easy to extinguish, and burn less than one-tenth of an acre. Such fires only burn a single snag and a small area of duff and/or fine fuels on the forest floor adjacent to the snag.

"Intense" fire behavior in lodgepole pine occurs during extended periods of little or no rainfall. Fuel moisture levels drop and fires are ignited by lightning during thunderstorms. These starts spread at steady rates of one to five acres per day in areas where there is an understory of spruce and fir trees to carry the fire. Fire spread is mainly through the understory and from log to log, occasionally torching individual trees with some short-range spotting. The "intense" scenario weather conditions are such that just enough precipitation is received at intervals of 10 to 14 days to keep the fire danger below the extreme level. Fires ignited under these conditions may burn for months, consuming 1000 to 4000 acres; most acreage is burned during one or two short duration crown fire "runs" driven by high winds under dry conditions.

"Extreme" fire behavior conditions result when fires that start in old-growth lodgepole pine stands (LP3) containing an understory of spruce and fir reproduction are driven by high winds and become very large. Other factors contributing to "extreme" fire behavior include: (1) a

significant understory of ladder fuels; (2) drought conditions or long-term drying where 1000-hour fuel (logs 3 to 8 inches diameter-at-breast-height [DBH]) moisture values drop below 10 percent; and (3) high winds sustained for a significant period of time, such as would be experienced in the passage of a dry cold front with strong winds aloft. The resultant fire behavior is an independent crown fire driven by high winds with short duration sustained runs of 10 miles per hour. Long-range spotting occurs ahead of the main fire front. Fire intensities will be sustained until significant precipitation occurs or high winds cease. These fires will be beyond the capabilities of any suppression efforts.

2. Douglas-fir Fuel Types and Associated Fire Behavior

The typical fire in the Douglas-fir fuel type begins in an isolated pocket of the stand, then simply goes out without spreading into the sagebrush and grass. The potential for the fire to spread into dead grass fuels is reduced due to grazing by elk and bison. In summer months, greenup of the grass hinders fire spread. In the fall, the potential fire spread is reduced because grass fuels often remain green until the first snowfall, and ignition sources diminish with the cessation of lightning storms around mid-September. Fire spread in this fuel type is dependent upon fire being carried by the grass, burning into the crowns of sagebrush, and being spread by high winds from bush to bush. With low winds, fire creeps through the grass, scolders, and then burns out when temperatures drop and relative humidity rises.

DOUGLAS-FIR COVER TYPES



COVER TYPE - 20 (DF0)

The DF0 cover type is characterized by burned or harvested Douglas-fir stands in the grass to seedling/sapling stage before canopy closure. Reproduction is mainly Douglas-fir.



COVER TYPE - 21 (DF1)

The DF1 cover type is a closed canopy of usually dense, even-aged Douglas-fir where trees are younger and shorter than those of neighboring stands. This type is a young successional stage and is approximately 40 to 100 years post-fire.



COVER TYPE - 22 (DF2)

The DF2 cover type is a closed canopy dominated by Douglas-fir. The overstory is still largely intact. It is considered a middle-aged Douglas-fir successional stage. The understory is usually small to medium Douglas-fir seedlings and saplings. This type is approximately 100 to 200 years post-fire.



COVER TYPE - 23 (DF3)

The DF3 cover type is defined as having a ragged canopy of predominately middle-age to old-growth Douglas-fir but also containing some Engelmann spruce, subalpine fir, or whitebark pine in the pole-size class. It is an old-growth Douglas-fir successional stage. The understory is small to large spruce and fir seedlings and saplings. This type is three hundred plus years post-fire.



COVER TYPE - 24 (DF)

The DF cover type is defined as climax to near climax stands dominated by mature to old-growth Douglas-fir, often found in scattered islands surrounded by non-forested lands.

The most representative fire danger model for the Douglas-fir fuel type is NFDRS Model H. This model describes healthy stands with sparse undergrowth and a thin layer of ground fuels. Fires in Model H fuel types are typically slow spreading; intensities are high only in scattered areas where downed woody material is concentrated. In dense stands of old-growth Douglas-fir with a heavy accumulation of litter and downed woody material, Fuel Model G is more representative. Fuels dominated by sagebrush and grass in the Douglas-fir fuel type are best represented by Fuel Model T. This model reflects the spread rate and intensity to be expected if a fire was to burn into or originate in sagebrush.

The most representative NFFL fire behavior predictive model for the Douglas-fir type having a sparse understory is Model 8, closed timber litter. Fuel Model 10 (timber litter and understory) would best represent old-growth Douglas-fir having a heavy accumulation of litter with down and dead material. In stands where fire spread is carried by grasses, Fuel Model 2 (grass with timber overstory) may be the most representative.

"Normal" fire behavior in the Douglas-fir fuel type depends on summer weather conditions. Normally, summer precipitation keeps fuel moisture content relatively high in both down and dead material and live plants. Annual fire occurrence in Douglas-fir fuel types is low, averaging one to two ignitions. Commonly, a single lightning struck tree will smolder and involve only the litter and down, dead material in close proximity to the base of the tree. Fires may smolder for up to two weeks before burning out or being extinguished by thundershowers.

"Intense" fire behavior in Douglas-fir can also occur if there are periods of little or no rain for two weeks and 1000-hour timelag fuels dry to 12 percent. Fire occurrence can increase to five to seven fires in an average "intense" year. These fires "torch out" individual trees and creep in litter and understory vegetation to surrounding fuels, involving more trees and small areas of sagebrush and grass. These fires are of moderate intensity in the large logs and tree trunks of Douglas-fir. To extinguish these fires a complete "mop-up" of the trunks and logs is required. Duff and litter layers are also consumed, and the fire will spread into sagebrush and grass where it will smolder and burn out, requiring little if any mop-up.

"Extreme" fire behavior is caused by drought with continued hot, dry weather from spring into the summer months. The 1000-hour fuels dry to moisture contents approaching 10 percent, while some early curing of grasses occurs. "Dry" lightning storms can start as many as seven

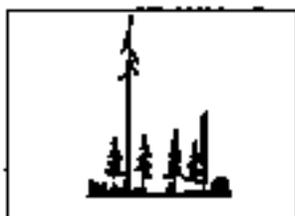
to ten fires during one storm. Fire spread is slow in surface fuels, but high fire intensities make these fires highly resistant to control, requiring large amounts of water and numerous personnel to halt the fire's spread. Many trees "crown out" during periods of high winds, sometimes causing spot fires to develop up to one-quarter mile downwind from the main fire. Fire also spreads to surrounding areas of sagebrush and cured grass, with a rapid spread through these areas driven by strong winds. Duff and litter layers are consumed down to mineral soil. Mop-up requires a major commitment of resources for many days.

3. Spruce/Fir Fuel Types and Associated Fire Behavior

Typical spruce/fir stands are dominated by Engelmann spruce and subalpine fir in both the overstory and understory. Lodgepole pine, Douglas-fir, or whitebark pine may be present. In many areas, lodgepole pine may be a significant species component while whitebark pine may be the dominant species at higher elevations.

Most spruce/fir stands are located in moist areas with supplemental ground water. Fuels consist of grasses, herbs, shrubs, and all age classes of spruce and fir trees.

SPRUCE/FIR COVER TYPES



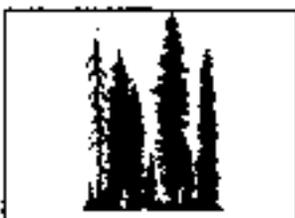
COVER TYPE - 40 (SF0)

The SF0 cover type is found in recently disturbed wet areas or high elevation cirques where reproduction is clearly dominated by Engelmann spruce and subalpine fir. Canopy closure has not been achieved.



COVER TYPE - 41 (SF1)

The SF1 cover type is an even-aged, closed stand dominated by sapling to pole-size Engelmann spruce and subalpine fir. Whitebark pine may also be present in significant numbers. This type commonly occurs in high-elevation cirques where shade and late melting snow make conditions unfavorable for lodgepole pine and whitebark pine. This type may also be found in wet sites at lower elevations.



COVER TYPE - 44 (SF)

The SF cover type is a stand dominated by Engelmann spruce and subalpine fir in both overstory and understory. Lodgepole pine, Douglas-fir, or whitebark pine may be present, but are a minor stand component.

"Normal" fire behavior in spruce/fir stands is of low intensity due to the wet sites this fuel type inhabits. These sites are wet enough to retard a fire's spread through carrier fuels. Single trees will "torch out" when struck by lightning, but fire generally does not spread from the spruce/fir type to other fuel types under normal conditions.

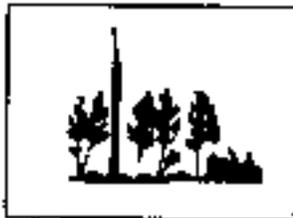
"Intense" fire behavior in spruce/fir stands occurs when fire spreads into other fuel types. This may occur late in the fall when cured vegetation dries out sufficiently to carry a fire. Ladder fuels are characteristic of this fuel type, and under dry conditions individual and small groups of trees may "torch out" and spread the fire through short-range spotting. Strong winds may spread the fire from crown to crown independent of the surface fire.

"Extreme" fire behavior is possible only under extended drought conditions when ground water dries up, reducing fuel moistures to levels low enough to allow surface fires to spread rapidly with intensities high enough to involve the tree crowns. Groups of trees may "torch" and the fire will then spread from crown to crown and by spotting. Lightning struck spruce or fir trees will readily ignite in drought conditions and carry fire into lodgepole pine and Douglas-fir stands. These fires have the potential to burn large acreages.

4. Whitebark Pine Fuel Types and Associated Fire Behavior

Whitebark pine is found at high elevations and is generally associated with Engelmann spruce, subalpine fir, and lodgepole pine. The understory of these stands is dominated by whitebark pine and may contain Engelmann spruce and subalpine fir. The understory provides sufficient ladder fuels to spread fire into tree crowns. Typically, whitebark pine only dries out in drought years. Whitebark pine stands exhibit similar fire behavior as lodgepole pine does, except they are located at higher, cooler, and wetter sites and, therefore, do not burn as frequently.

WHITEBARK PINE COVER TYPES



COVER TYPE - 50 (WB0)

The WB0 cover type is found in recently burned whitebark pine stands, usually located near upper timberline where whitebark pine clearly dominates reproduction.



COVER TYPE - 51 (WB1)

The WB1 cover type is an even-aged, closed whitebark pine stand where trees are younger and shorter than those of neighboring stands. Trees are small pole-size.



COVER TYPE - 52 (WB2)

The WB2 cover type is a closed canopy dominated by whitebark pine. The overstory is still largely intact. Trees are pole- to mature- size. The understory is usually composed of small to medium Engelmann spruce and subalpine fir seedlings and saplings but may be mostly whitebark pine. These stands are approximately 100 to 300 years post-fire.



COVER TYPE - 53 (WB3)

The WB3 cover type is a stand dominated by middle-age whitebark pine which may also contain considerable Engelmann spruce, subalpine fir, or lodgepole pine. The understory is a combination of Engelmann spruce, subalpine fir, and whitebark pine.



COVER TYPE - 54 (WB)

The WB cover type is a stand of middle-age to old-growth whitebark pine where the reproduction is mostly whitebark pine.

Fire behavior in "normal" and "intense" years generally involves a tree struck by lightning which burns a small area of grass, litter, and duff in close proximity to the base of that tree. Stands with significant understory fuels may experience the spread of the fire through ladder fuels into tree crowns. Strong winds are necessary to spread the fire by spotting or independent crown fire.

"Extreme" fire behavior occurs only in drought years. In these dry years, fire can be expected to crown and spot, especially in stands where spruce and fir form a significant part of the understory. Strong winds are necessary to sustain continued fire spread in whitebark pine.

5. Aspen Fuel Types and Associated Fire Behavior

Fire behavior in aspen is usually limited to slow moving, wind-driven fires carried by grass. Grassy fuels normally do not cure until late September, well past the normal lightning storm season.

ASPEN COVER TYPES



COVER TYPE - 70 (ASPD)

The ASPD cover type is an early post-disturbance aspen stand with predominantly sapling size trees. Trees are usually less than 10 feet tall. Some stands may be maintained in this type by harsh environmental conditions, heavy browsing, or both.



COVER TYPE - 71 (ASP1)

The ASP1 cover type is a stand of predominantly small, pole-size, usually vigorous trees. Some stands may be relatively old but stunted by environmental conditions.



COVER TYPE - 72 (ASP2)

The ASP2 cover type is a stand of pole-size to middle-age trees with more-or-less even canopy and little mortality.



COVER TYPE - 73 (ASP3)

The ASP3 cover type is a middle-age to old-growth stand with conifer species well represented to abundant in sapling to pole-size or occasionally mature-size age classes. The overstory is at or near the point of breaking up and being replaced by the emerging conifer understorey.



COVER TYPE - 74 (ASP)

The ASP cover type is a mature to old-growth stand where aspen is the climax or at least a long persistent seral species. Sapling or pole-size aspen are usually well represented and indicate the persistence of aspen dominance through at least another stand cycle. The presence of conifer species is limited to a few individuals, typically sapling to mature age classes.

Historically, fire starts in aspen fuel types are caused by humans. Most aspen stands do not have a significant down and dead component; consequently, fires are of low intensity and are relatively easy to suppress. Natural fires in these types are not common. Normally a fire would spread only through the grass into adjacent sagebrush fuels and go out either when the wind stops or when the relative humidity increases at night.

6. Miscellaneous Fuel Types and Associated Fire Behavior

These remaining fuel types, consisting of limber pine and mixed forest types, are not found in large acreages in Yellowstone. They are not significant with regard to numbers of fire starts, acres burned, or fire spread. The potential does exist in dry years for fire to spread into these fuels from lodgepole pine, Douglas-fir, spruce/fir, or whitebark pine fuel types.

LIMBER PINE COVER TYPES



COVER TYPE - 13 (LI3)

The LI3 cover type is a stand dominated by middle-age limber pine which may also contain considerable Douglas-fir, Engelmann spruce, subalpine fir, or lodgepole pine. The understory is a combination of Douglas-fir or Engelmann spruce and subalpine fir.



COVER TYPE - 14 (LI)

The LI cover type is a stand of middle-age to old-growth limber pine where the reproduction is mostly limber pine. This type and the preceding type are almost exclusively found on the east slopes of the Absaroka Range.



COVER TYPE - 64 (OW)

The OW cover type is open woodland with juniper dominant. Douglas-fir and limber pine are present and sometimes dwarfed in appearance due to extremely harsh site conditions. The understory species are dominated by bluebunch wheatgrass, Idaho fescue, and sagebrush. The tree density is often capable of providing cover for wildlife.

MIXED FOREST TYPES

MF1 - The MF1 cover type is a mixed forest stand in an early successional stage. The canopy is typically closed and comprised of sapling to pole-size trees.

MF2 - The MF2 cover type is a stand of large pole to middle-size trees in a mid-successional stage. These stands are still more-or-less even-aged structure.

MF - The MF cover type is a late successional to climax stage with varied structure and age class representation. Middle-age to old-growth individuals of "early" and "late" successional species are found in the overstory.

MISCELLANEOUS TYPES

LPP - The LPP cover type is a lodgepole pine pygmy forest (height to ten feet) found mainly on the Madison Plateau. Multi-age dwarf lodgepole pine occur with a grass understory.

KH - The KH cover type is a Krumboltz stand consisting of dwarfed, wind-shaped Engelmann spruce, subalpine fir, and whitebark pine stands. This type is usually found in islands interspersed in nonforest areas at the upper tree line.

E. Annual Fire Weather Cycle

Average annual precipitation totals range from a high of 32.64 inches at the South Entrance to a low of 15.45 inches at Mammoth (Wyoming Climate Atlas 1986). High elevations and associated long winters produce significant snowfall which makes up the majority of precipitation received in Yellowstone. Snowfall totals range from a high of 244 inches at the South Entrance to a low of 75 inches at Mammoth. Snowpack begins in early October for elevations above 9,000 feet and in late October for elevations around 7,000 feet. The snowpack melts in late May at the 7,000 foot level and in early July at 9,000 feet. The average duration of snowpack is 213 days at 7,000 feet and 271 days at 9,000 feet (Despain 1990).

Periods of below-average snowpack and precipitation are common in Yellowstone, and this influences the fuel moisture content of spring grass, duff, and litter at lower elevations as well as the 1000-hour fuel moisture content throughout the fire season. When a normal snowpack is received and snowmelt is gradual throughout the spring, fuel moistures start at much higher levels, and a very dry summer is required to significantly reduce the levels.

The normal fire season begins in mid-June and lasts until mid-September. Critical factors influencing the fire season include the number of summer lightning storms and the timing and amount of summer precipitation. Since the majority of fires are started by lightning, the periods in spring before the grasses greenup and in the fall after dormancy and before snowfall begins, are normally periods of few fire starts. Summer drought conditions and frequent lightning storms can result in many fire starts, with the potential for large acreages to burn.

The normal fire weather pattern is one where adequate amounts of precipitation fall during the months of June through September. The fuel moisture content of all vegetation drops as the season progresses (1000-hour time-lag fuel moisture contents average around 18 percent mid-June), fires are started by lightning, and these same thunderstorms also extinguish the fires just started, thus lowering the fire danger. This cycle repeats itself every 10 to 14 days, with 1000-hour fuels drying to 14 percent moisture content levels but kept from further drying by frequent afternoon thundershowers. An average of 15 prescribed natural fires would be started by lightning in a normal season, burning less than ten acres total.

A wet summer fire weather pattern is one where above average precipitation maintains the 1000-hour fuel moisture content of vegetation at a level of 18 percent or greater throughout the summer. This wetter weather pattern would produce fewer lightning storms, and the lightning experienced would be accompanied by moderate to heavy rainfall. An average of ten prescribed natural fires would burn less than five acres total.

A dry or drought summer weather pattern is one where precipitation remains below average for the months of June through September. The 1000-hour fuel moisture content readings emerge from winter snowpack at about 30 percent and steadily dry throughout the summer to as low as 8 percent (as measured in 1988). Periodic dry thunderstorms, storms producing lightning accompanied by very little or no rainfall, could ignite an average of 40 fires. Fires that start in the Prescribed Natural Fire Zone and remain within prescription may burn more than 20,000 acres in such a summer. Between 1972 and 1987, prescribed natural fires, burned more than 1000 acres in only 3 of those 16 years. These three years averaged 15 natural starts per year and burned an average of 2,135 acres each year. It is significant to note that in 10 of those 16 years less than 10 total acres were burned.

VII. FIRE MANAGEMENT AND RESPONSIBILITIES

A. *Fire Management Responsibilities*

This section discusses the responsibility, by specific park staff positions, for implementation of the fire management program. This section, then, clearly defines the areas of responsibility, provides clear direction and accountability, and furthers the development of a responsive fire management program (see Table 1).

Superintendent

Fire management in Yellowstone National Park is the responsibility of the Superintendent, with technical duties and accompanying responsibilities delegated to staff members. The Superintendent will be responsible for management of the program under Departmental and National Park Service policy, the Wildland Fire Management Guideline (NPS-18), and all relevant laws and regulations. The Superintendent is responsible for:

--Ensuring that a comprehensive fire management program is adequately planned, staffed, and implemented, and that the Fire Management Plan is reviewed annually and revised as necessary.

--Maintaining and facilitating public and media relations pertaining to both suppression efforts and prescribed fires.

--Preparing and approving Escaped Fire Situation Analysis (EFSA).

--Approving all prescribed natural fires (PNF) and validating, on a daily basis, that each PNF is predicted to remain within prescription and adequate funding is available to continue monitoring duties. The Superintendent verifies that sufficient suppression personnel and funding are available if a PNF is declared a wildfire.

Assistant Superintendent

--All decision-making responsibility is delegated to the Assistant Superintendent when the Superintendent is absent from the park.

Chief Ranger

--Responsible for implementation and execution of all aspects of the Fire Management Program, except research.

--Responsible for overall coordination, direction, and supervision of wildfire prevention, presuppression, and suppression. The Chief Ranger has line authority over the Fire Management Officer and District Rangers and coordinates all serious wildfire emergencies.

--Serves as chairperson of the Fire Management Committee and presents approved committee recommendations to the Superintendent.

--Briefs the Superintendent and Assistant Superintendent on current and predicted fire management activity.

--Recommends approval of the Fire Management Plan to the Superintendent.

Assistant Chief Ranger

--All decision-making responsibility is delegated to the Assistant Chief Ranger when the Chief Ranger is absent.

--Serves as advisor to the Chief Ranger for all planning and decision-making processes regarding fire management operations.

--Serves as a member of the Fire Management Committee.

Fire and Emergency Operations Specialist

--Directly supervises the Fire Management Officer and Structural Fire Chief, coordinating all major fire emergencies in the park.

--Coordinates with District Rangers and other Division Chiefs to mobilize personnel and equipment to meet park emergencies.

--Briefs and updates the Chief Ranger on current and predicted fire management activity.

--Serves as a member of the Fire Management Committee.

--Represents the park and region on regional interagency committees that provide direction for wildland fire cooperation.

District Rangers

--Responsible for coordinating fire management activity in their respective district in consultation with the park Fire Management Officer.

--Responsible for identifying presuppression activity in their respective district.

--Coordinates with the Fire Management Officer on all actions regarding wildfire suppression, dispatch of personnel, and monitoring of prescribed natural fires and management-ignited prescribed fires in their respective district.

--Coordinates with the Fire Management Officer to prioritize their respective district staff for needed training and wildland fire assignments.

--Serve as members of the Fire Management Committee for fires within their respective district.

--Coordinate the administration of the step test for qualified firefighters within their respective district, certifying the results, and relaying the test results to Fire Management Officer.

Fire Management Officer

--Responsible for fire management program activities. Prepares and administers the Fire Management Plan and the annual FIREPRO budget. He/she revises the plan as needed to incorporate any necessary changes.

--Advises and informs the Chief Ranger of all information on fire activity in a prioritized order.

- Responsible for completing the prevention analysis which determines the level and type of prevention effort required by the park.
- Responsible for implementation of the appropriate suppression response as recommended by the Fire Management Committee.
- Responsible for the safe suppression of all wildfires, including initial attack, demobilization, and rehabilitation of the burned area.
- Responsible for submission of daily fire situation reports during fire season to the NPS Branch of Fire and Aviation Management, Regional Fire Management Officer, and Greater Yellowstone Coordination Committee (GYCC).
- Responsible for assigning fire monitors to prescribed natural fires and for completing daily Fire Situation Analysis (FSA) to determine if the fire(s) will remain within prescription parameters.
- Responsible for providing fire training opportunities to park personnel in order to maintain predetermined fire qualification skills in critical positions. He/she reviews, updates, maintains, and enters fire training and fire experience records into the NPS Wildland Fire Management Computer System.
- Ensures adequate inventory of equipment and supplies so that the fire management program can be efficiently implemented.
- Develops the annual management-ignited prescribed fire program, including the writing of prescribed burn plans and implementing all approved prescribed burns.
- Ensures the preparation of individual prescribed burn plans in accordance with NPS-18 guidelines and authorizes each burn plan by reviewing and signing the plan.
- Ensures that both a briefing statement and delegation of authority are prepared for the incoming Incident Management Teams.
- Ensures implementation of the approved fire prevention program.
- Maintains daily contact with the Regional Fire Management Officer, West Yellowstone Interagency Coordination Center, and Northern Region Coordination Office in Missoula, Montana, during fire season through the fire situation reporting system.
- Coordinates the dispatch of park personnel for in-park fire assignments or to provide assistance to other parks and agencies.
- Requisitions aircraft, smokejumpers, fire crews, or fire resources and supplies for use within the park.
- Ensures maintenance of all fire weather stations, and ensures that daily weather observations are taken, properly reported, and correctly entered into the AFFIRMS program. Interprets daily NFDRS indices and informs Emergency Operations Coordinator when Staffing Class III levels are reached.
- Prepares, reviews, and revises cooperative agreements with interagency cooperators. Maintains liaison with interagency cooperators through annual meetings where agreements are reviewed.

--Maintains technical references, maps, and aerial photos for fire management assessment of active fires.

--Responsible for completion of all fire reports (DI-1202s) and the timely entry of reports into the NPS Fire Management Computer System.

--Serves as a member of the Fire Management Committee. Prepares necessary evaluation information for each fire, provides timely update of current and predicted fire behavior, and provides technical advice and recommendations to the committee.

Assistant Fire Management Officer

--All decision making responsibility is delegated to the Assistant Fire Management Officer when the Fire Management Officer is absent.

--Responsible for daily supervision of the emergency fire cache personnel, which includes the helitack foreman, fire dispatcher, fire monitors, and fire lookouts.

--Responsible for maintaining emergency fire cache inventory.

--Ensures that necessary equipment is in adequate supply, is accounted for, and is maintained in proper working order.

--Administers park helicopter contract; is designated as the Contract Officers Administrative Representative (COAR). Responsible to the Fire Management Officer for safe utilization and management of all park aircraft.

--Serves as course coordinator/lead instructor for fire management and aviation courses provided in the park.

--Responsible for helirappel and short haul program. Maintains equipment, certifies that training standards are met and proficiency is maintained by park and cooperator personnel, and that training records are kept current and updated.

Helitack Foreman

--Supervises the helitack crew and daily field helicopter operations. Ensures that helicopter operations are performed in a safe manner, following all aviation regulations. Completes OAS-23 forms on daily basis.

--Serves as an instructor in fire management, aviation, helirappel, and short-haul training courses.

--Provides technical advice and recommendations to the Emergency and Air Operations Specialist and Fire Management Officer. Serves as the Initial Attack Incident Commander and Lead Fire Monitor when necessary.

Fire Program Clerk

--Records Fire Management Committee minutes and maintains the files for all park fires.

--Tracks FIREPRO budget; prepares time and attendance reports, travel authorizations, submits travel vouchers, and prepares hiring packets for fire management staff.

-Updates fire experience and training records for park personnel in the NPS fire qualification system. Inputs DI 1202a into NPS wildland computer data base.

Fire Dispatcher

-Receives initial reports of all fires and completes smoke report with all pertinent information.

-Immediately notifies Fire Management Officer and relays fire information to District Ranger. Facilitates dispatch process by contacting initial attack personnel and initiates flight following.

-Maintains computer list of red-carded personnel for dispatch purposes for both in-park situations and assistance to interagency cooperators. Completes resource order form properly and updates information for resource tracking purposes.

-Inputs daily fire weather data into AFFIRMS, updates daily situation reports, requests daily fire weather, requests daily situation and resource report, requests daily fire danger indices, and posts all information on fire management bulletin board.

Research Administrator

-Assigns a research representative to serve on the Fire Management Committee.

-Coordinates fire research efforts.

Park Public Affairs/Information Officer

-Prepares and releases information about the fire management program and current fire activity. Serves as liaison between news media and park staff, providing timely and accurate fire information updates.

-Responsible for collecting, cataloging, filing, storing, and maintaining archives of pertinent large fire records for fires that burn in Yellowstone.

-Assists government employees and private citizens in location of fire records on as-needed basis.

Fire Lookout

-Responsible for immediately reporting new fire starts to the fire dispatcher and providing the information needed to complete the smoke report. Provides timely updates of changes in fire behavior and serves as initial fire monitor until on-site monitors arrive.

-Maintains fire weather station, reporting daily fire weather information to fire dispatcher. Reports any significant weather changes that may affect fire behavior.

Prescribed Fire Manager/Prescribed Burn Boss

-Responsible for the management of prescribed natural fires and management-ignited prescribed fires from the time of assignment until the fire is declared out or is declared a wildfire.

-Responsible for writing the Fire Situation Analysis (FSA) or Prescribed Burn Plan (PBP).

-Responsible for implementation of the Fire Situation Analyses or Prescribed Burn Plan.

--Responsible for gathering the necessary data to complete the daily update of the FSA and for the revalidation process.

--Supervises the fire behavior and weather specialists in performance of their information gathering duties.

--Determines when the fire is out and when personnel and equipment may be demobilized.

--Responsible for completion of final fire reports.

Fire Behavior and Weather Specialist

--Responsible for on-site monitoring of prescribed natural fires; this includes gathering fire behavior, fire weather, and fuel loading data and relaying this information to the Fire Management Officer.

--Responsible for gathering fuels information samples for fire management planning purposes.

Park Employees

--Responsible for reporting any new fire to fire dispatcher, noting time, location, fire behavior, and vegetation type.

B. Fire Management Committee

The Fire Management Committee consists of the Chief Ranger, Assistant Chief Ranger, Fire and Emergency Operations Specialist, Fire Management Officer, Assistant Fire Management Officer, Research Representative, and the affected District Ranger. The Chief Ranger will chair the Committee. Technical expertise from other individuals may be requested by the Committee at any time. Each committee member will designate an alternate to serve in the event that he or she is unavailable. A quorum will consist of at least the Chief Ranger, Fire Management Officer, and affected District Ranger or their designated alternate(s).

1. Committee Actions During Prescribed Natural Fires

The Committee will evaluate all new fire starts in the Prescribed Natural Fire and Conditional Fire zones. The Committee will be convened by the Chief Ranger immediately upon confirmation that a lightning-caused fire is burning in either of the above-mentioned zones. All human-caused fires will be immediately suppressed. The Fire Management Officer will present fire information to the Committee through the Fire Situation Analysis (FSA) report. The fire will be evaluated as a candidate prescribed natural fire according to the Fire Decision Flow Chart (see Table 5) and Prescription Parameters (see Tables 7 and 8) to determine if it is within prescription and can be managed as a prescribed natural fire. If the reported fire does not meet the prescription parameters, it will be declared a wildfire and suppressed utilizing confine, contain, or control strategies, or a combination of these. The Chief Ranger will present the Fire Management Committee's recommendation to the Superintendent. Upon written approval from the Superintendent, the Fire Management Officer will implement the approved course of action.

During any active prescribed natural fire, the Chief Ranger, representing the Committee, will brief the Superintendent on the current fire situation as often as necessary, but at least once daily. Alternatives and recommendations for any change in the management strategy of the fire will be presented. During the progress of any prescribed natural fire, the Committee will ensure that a contingency plan is prepared should the fire exceed prescription. The daily fire situation analysis (FSA) will be completed by the Fire Management Officer, and a determination of whether the fire is

to continue as a prescribed natural fire or declared a wildfire will be made by the Committee. The Superintendent has final and complete authority for all fire management decisions. The Superintendent or his/her designated representative will sign the revalidated FSA each day.

2. Committee Actions During Fire Suppression Activities

A park Type III Incident Commander will be assigned to manage any fire being suppressed that threatens to exceed the park's initial attack capabilities. If a fire escapes initial attack, the Committee will ensure that an Escaped Fire Situation Analysis (EFSA) is prepared.

3. Committee Actions During Non-Fire Periods

The Committee may be convened during periods of high fire danger to coordinate pre-suppression activities and formulate recommendations regarding travel restrictions and area closures. A pre- and post- fire season meeting of the Committee will be convened to coordinate and critique the Committee's operation and function.

C. Fire Qualifications

FIREPRO (the NPS fire management analysis program) has been used to analyze the necessary level of fire qualification skills that must be available in order to manage the fire program in Yellowstone. Historic wildfire occurrence (based on a ten year average), commensurate with values at risk, indicates that the park should train and staff in-park qualified personnel to fill all positions on a Type II Incident Management Team. A qualified Prescribed Fire Manager/Prescribed Burn Boss position will also be maintained to competently manage complex prescribed natural fires and management-ignited prescribed fires.

All personnel involved in wildland fire suppression, prescribed burning, or fire monitoring will meet national standards as determined by the NPS Wildland Fire Qualifications System. All personnel involved in fire management operations will have their qualifications, training, and experience entered into the NPS Fire Qualifications System. Records will be updated annually, and a master list of park personnel and their qualifications will be available in the Fire Management Office for mobilization and dispatch purposes.

The wildland fire training program developed by the fire management staff is reviewed annually to prioritize training opportunities, budget training funds, nominate specific individuals for training courses, develop the annual park training schedule, and to provide training information to all park employees. Nominations for these courses will be submitted for those personnel who have met the prerequisites and have identified these courses in their annual Employee Development Plan. Fire training at various levels will be available to all park personnel with preference given to those that have wildfire and prescribed fire responsibilities as part of their position title. The Basic Firefighter (S-130) and Basic Fire Behavior (S-190) courses will be offered each spring to all interested personnel who wish to qualify at the firefighter level. Additional courses will be offered in-park as the need arises, and permanent personnel will be nominated to 300 level and higher courses at the regional and national level, based on park needs.

Physical fitness standards for all wildland firefighters will be maintained in accordance with NPS and Yellowstone guidelines. Permanent red-carded personnel will maintain these standards year-round in accordance with Yellowstone guidelines. Daily fitness programs are encouraged for all permanent personnel, and those involved in emergency services will be required to be involved in a physical fitness program.

D. Interagency Coordination

A Memorandum of Agreement exists between Yellowstone National Park and the Gallatin National Forest for coordinating suppression of forest fires in and around the towns of West Yellowstone.

Gardiner, and Cooke City, Montana. The primary purpose is the protection of human life, private and public lands, and facilities. This memorandum was signed in 1991 (see Appendix E).

A Memorandum of Agreement exists between the National Park Service, Rocky Mountain Region (represented by Yellowstone National Park) and Regions 1, 2, and 4 of the U.S. Forest Service for the purpose of funding and operating the base facilities at the West Yellowstone Interagency Coordination Center (WYICC). The purpose of this agreement is to manage and fund the smokejumper, dispatch, and retardant operations at West Yellowstone which is administered by the Gallatin National Forest for wildland fire operations. This agreement was signed in 1990.

Yellowstone National Park participates in the Eastside Incident Management Team Program by providing qualified wildland fire personnel to serve as overhead team members. The Fire Management Officer is an interagency voting member on the oversight committee that annually revises the Eastside Incident Management Team Operating Plan and nominates and approves team members.

Yellowstone National Park cooperates with the Northern Training Center administered by Region 1 of the U.S. Forest Service in Missoula, Montana, for the purpose of conducting interagency training in wildland fire. The Fire Management Officer is a voting member on the training oversight committee that reviews the mission of the training center, proposes annual training courses, and determines which wildland fire courses will be offered on an annual basis.

Yellowstone National Park cooperates with the Montana Indian Firefighter (MIF) program administered by the Bureau of Indian Affairs in Billings, Montana. The Fire Management Officer is a member of the interagency oversight committee that annually reviews the program. Yellowstone also provides instructors for annual single resource boss-crew training offered through the program.

Yellowstone National Park represents the NPS Rocky Mountain Region on the Northern Rockies Coordinating Group which sets the direction and establishes guidelines for all matters concerning wildland fire in the Northern Rockies area. The park's Fire and Emergency Operation Specialist represents the Regional Fire Management Officer on this committee.

The greater Yellowstone area (GYA) is made up of six national forests and two national parks. Forest and park managers have recognized a need for coordination on a number of issues and programs which cross jurisdictional boundaries. The Greater Yellowstone Coordinating Committee (GYCC) was created because of this need. The committee consists of: regional foresters of the Intermountain, Northern, and Rocky Mountain regions of the U.S. Forest Service; the Regional Director of the Rocky Mountain Region of the National Park Service; forest supervisors of the Beaverhead, Custer, Gallatin, Shoshone, Targhee, and Bridger-Teton national forests; and Superintendents of Grand Teton and Yellowstone national parks.

Following the 1988 fires in the GYA, a Fire Management Policy Review Team issued a report examining federal fire policies. In response to this report, the GYCC addressed the recommendations of the team by developing the GYA Interagency Fire Management Planning and Coordination Guide. The guide had three objectives: (1) strengthen fire management planning within the GYA, (2) develop specific operating principles and procedures to provide effective interagency coordination and management of prescribed fires and wildfires occurring in the GYA, and (3) clearly define the role of the GYCC in fire management within the GYA.

To further improve interagency cooperation and strengthen fire management planning, a contingency plan has been developed for the GYA and is referred to as the GYA Preparedness Plan (see Appendix G). The purpose of this contingency plan is to ensure timely recognition of approaching

critical fire situations and to establish a process for making prompt decisions concerning priorities and actions necessary to resolve these situations.

A Memorandum of Agreement exists between all signatories of the GYA Interagency Fire Management Planning and Coordination Guide to allow prescribed natural fires to burn across agency boundaries (for all units that have approved fire management plans) and to jointly manage these wildfires that involve multiple agencies. This agreement was signed in March 1992.

Table I: Fire Management Responsibility Assignment for Decisions and Actions

Decision/Action	Responsible Position
Fire Management Planning	Fire Management Officer Review by Chief Ranger Approval by Superintendent
Wildfire Mobilization	Fire Management Officer Coordination with District Ranger and Division Chiefs
Prescribed Fire and Prescribed Natural Fire Mobilization	Fire Management Committee Recommendation by Chief Ranger Approval by Superintendent Implementation by FMO/DR
Fire Prevention	Fire Management Officer
Interagency Mobilization	Fire Management Officer Approval by Chief Ranger
Interagency Cooperation	Emergency Operation Coordinator Fire Management Officer
Fire Management Training	Fire Management Staff
Public Information	Public Affairs Officer/Staff
Fire Research	Research Staff
Public Safety	Chief Ranger/District Rangers Recommendations by Safety Officer
Archaeological/ Historical	Cultural Resource Management Specialist Resource Management Specialist

VIII. WILDFIRE MANAGEMENT PROGRAM

The wildfire management program describes operational procedures necessary to implement wildland fire management in Yellowstone National Park. Program management includes: fire prevention, presuppression, emergency presuppression, fire behavior predictions, a step-up staffing plan, fire detection, fire suppression, minimum-impact suppression, minimum-impact rehabilitation, and fire records and reports.

Fire season in Yellowstone is based on historical weather and fire occurrence statistics as analyzed by FIREPRO. The fire season begins June 15 and ends September 30.

A. Fire Prevention Program

The fire prevention program is designed to determine the human-caused fire threat to Yellowstone and to define specific actions to reduce that threat. This information is integrated into the fire management program. The wildfire prevention efforts are directed toward ignitions that pose the greatest potential for causing unacceptable damage or loss.

During the planning process for wildfire prevention, it is necessary to assess and identify all potential threats and problem areas. The analysis for Yellowstone was completed according to NPS-19, Chapter 11, and the NPS Fire Prevention Handbook. The analysis evaluated risks, hazards, and values. For each area of the park, separate overlays were prepared to compare the potential for an ignition (risks) with the potential to burn after ignition (hazards) along with the values threatened by a wildfire (values). The information on each overlay was compiled and transferred to a single park base map which was digitized into the park's GIS files for permanent storage. The complete fire prevention analysis is located in Appendix J in this plan.

1. Objectives

The overall objective of the fire prevention program is to identify the cause of each fire and to minimize human-caused fires through general and specific actions. The fire prevention analysis has established objectives and general actions.

The objectives are:

- Define the human-caused threat and determine specific actions to reduce that threat.
- Integrate the prevention message into all visitor contact messages.
- Increase interagency and community awareness of the fire prevention program.
- Improve relationships with interagency cooperators and local communities through the fire prevention program.
- Increase employee awareness and involvement in the fire prevention program.

2. General Actions

The general actions are designed to address the major causes of human-caused fires in Yellowstone (in the last ten years). These causes are: unattended and escaped campfires, fires resulting from smokers, and powerline fires.

- A fire prevention message addressing campfires and smoking will be incorporated into the backcountry and special use permitting system and made available to each camper. This message will be posted in each picnic area and campground and at each trailhead registration box. This

message will also be incorporated into the information packet distributed at each entrance station and visitor center.

-The fire prevention messages will be translated into the most commonly used foreign languages and incorporated into the information packets distributed to foreign visitors at entrance stations and visitor centers.

-Daily notification of the fire danger levels will posted at entrance stations, trailheads, and visitor centers.

-All park and concession employees will be given fire prevention awareness education.

-A program will be developed with Montana Power designed to reduce fires caused by powerlines. This program will include burying powerlines, routinely inspecting the powerline corridor after high wind events, and clearing the right-of-way of hazard trees.

All human-caused fires will be declared wildfires and suppressed. The fire prevention program will give the highest priority to protection of human life.

B. Annual Schedule for Fire Prevention Program

October 1 - April 30. The Fire Management Officer will critique the fire prevention program with the Fire Management Committee and incorporate recommendations into the Fire Management Plan for implementation by the next fire season. The Fire Management Officer will meet with interagency cooperators to critique the greater Yellowstone area fire prevention program during the past fire season. The Fire Management Officer will review the fire prevention program and determine the percentage of the budget dedicated to fire prevention efforts. Any new techniques, information, or procedures that have proven successful in reducing human-caused fires in other areas will be included. Meetings will be held with park staff to discuss implementation of the fire prevention program for the upcoming fire season. Meetings with interagency cooperators will be held to discuss the implementation of the fire prevention program in the greater Yellowstone area for the upcoming fire season. The Fire Management Officer will ensure that necessary fire prevention information is included in the park newspaper.

May 1 - September 30. The Fire Management Officer and staff will implement the fire prevention program within Yellowstone. They will investigate all human-caused fires, assist the law enforcement staff in prosecuting responsible parties when necessary, and complete fire reports and case incident reports. All fire prevention information will be provided through the Interpretation and Ranger divisions. The FMO and staff will monitor visitor response to the current fire prevention program.

C. Presuppression

As directed by the Fire Management Plan, presuppression activities are carried out prior to a fire occurrence to ensure that the appropriate response to that fire can be accomplished. Presuppression activities include: budget planning, equipment acquisition, equipment maintenance, equipment inventory, recruitment, and training. The objective of the presuppression effort is to have a well-trained and well-equipped fire management organization in place to manage all fire situations within Yellowstone National Park. Presuppression activities are outlined in NPS-18 and are covered by normal park operating funds and supplemented with FIREPRO funding.

The fire season, as determined by the FIREPRO analysis during presuppression planning, is from June 15th through September 30th. Presuppression efforts are to be accomplished outside the

normal fire season dates. When periods of high fire danger occur outside the normal fire season dates, the appropriate action will be taken, and justification for funding such actions will be sent, in writing, to the Regional Fire Management Officer.

The following presuppression actions will be taken to ensure adequate fire preparedness.

October 1 - June 14. Necessary training for permanent employees will be provided by offering in-park courses or sending employees to locations where training is being offered. Physical exams are required every three years for permanent personnel who are available for wildland fire assignments. Employee training and experience records will be updated on the NPS Wildland Fire Qualifications Computer System prior to each fire season. Necessary maintenance on all fire equipment will be accomplished prior to each fire season. Memorandums of Understanding and Memorandums of Agreement with interagency cooperators will be reviewed on an annual basis. The Fire Management Plan will be reviewed and updated as necessary by June 1 each year. Prescribed burn plans will be written, and the approval process initiated. Winter snowpack, water level, and drought information will be monitored for potential impacts to Yellowstone's fire season. Seasonal personnel vacancy announcements will be issued, and personnel will be recruited. The seasonal training schedule will be written, and firm dates and location of training will be determined. All fire equipment will be inventoried, and the equipment location list updated. The portable pumps and chainsaws will be tested and operational. All initial attack/helitack support vehicles will be inventoried and equipped. In order to follow the fire danger trend for the upcoming fire season, fire weather observations will begin at the Mammoth weather station when the snow melts around the station area. Refresher training for the seasonal helitack crew will be offered during the first two weeks of June. Meetings with the Office of Aircraft Services personnel and the helicopter contractor will be held to complete the helicopter contract requirements and set the date for inspection of the contract helicopter.

June 15 - September 30. A state of readiness will be maintained as outlined in the step-up plan. Seven-day-a-week fire management operations will be initiated as necessary. Equipment will be issued to all seasonal personnel and training completed. The helicopter contract will be completed, and the contract helicopter inspected. Fire lookouts will begin operation. Operation of the remaining fire weather stations will begin. Sampling and weighing of live and dead fuels and tracking of 1000-hour fuel moistures will begin. Fire situation reporting will begin and the reports will be sent to the NPS Fire Management Office in Boise, Idaho, and to the Region 1 Coordination Center for monitoring of fire danger in the GYA.

Fire Danger Monitoring. Yellowstone maintains seven staffed fire weather stations and two Remote Automatic Weather Stations (RAWS). These stations are maintained according to the standards defined in the Fire Weather Observers Handbook. These stations are located to represent all fuel types, elevations, and topographic locations found in Yellowstone. Daily fire weather observations are entered into AFFIRMS (Administrative Forest Fire Information Retrieval and Management System) beginning May 1 at the Mammoth station and continuing until snowfall begins in the fall. The fire management staff monitors the daily fire danger indices, fire weather forecasts, and local and national situation reports in order to remain informed and prepared to manage all fire situations throughout the fire season. The above mentioned reports are posted daily in the Fire Management Office and current fire danger information is provided to the District Rangers, Chief Ranger, and Communication Center.

Equipment. A central fire cache is located at park headquarters in Mammoth Hot Springs. A two hundred person fire cache is maintained in addition to supplying each district with ten complete individual firefighter initial attack packs and tools. Mark III portable pumps will be prepositioned at

Boehler Ranger Station with additional pumps located at Mammoth. An adequate supply of radios and chainsaws will be maintained at Mammoth.

D. Emergency Presuppression

Emergency presuppression describes actions taken to provide extra coverage during times of extreme or unusual fire danger caused by meteorological influences on the park's vegetative complex. Examples of this are strong and/or dry winds, dry thunderstorms, or prolonged local or regional drought. These unusual occurrences will be addressed by planned use of emergency presuppression funds linked to the National Fire Danger Rating System (NFDRS) Burning Index and described in the step-up plan (see Table 4). The park's authority to expend emergency presuppression funds is detailed in NPS-18. Appropriate activities for use of emergency presuppression funds include: hiring of temporary emergency firefighters, placing existing staff on extended tours of duty, increasing or initiating special detection operations, and hiring fixed-wing or rotary aircraft to accomplish necessary preparation. These actions are aimed at ensuring prompt response with adequate forces should fires occur.

Authorization to expend funds beyond the expenditures pre-identified in the step-up staffing plan will be obtained from the Regional Fire Management Officer who will analyze the justification presented. These funds may be used for daily monitoring of fires within prescribed natural fire zones.

E. Fire Behavior Predictions

Yellowstone National Park uses the National Fire Danger Rating System (NFDRS) (Doering et al. 1978), which provides daily fire danger indices relating to the potential and expected fire behavior for fires that start on that particular day. The NFDRS indices provide a broad planning estimate of "worst case" fire potential and is used as a broad preparedness tool, focusing on the Burning Index (BI), Energy Release Component (ERC), 1000-hour timelag fuel moisture content, and Lightning Activity Level (LAL). The system addresses fire danger and potential, with the components and indices being structured so that they are linearly related to the particular aspect of the fire being rated. Fire danger is rated for a worst-case scenario by fire weather observations which are taken during the heat of the day. The NFDRS does not predict how every fire will behave but is intended to provide guidance for long-range planning. It is the basis for daily fire planning in the Yellowstone's fire management program. It evaluates the near upper limit of the behavior of fires expected in a rated area during the rated period.

The Burning Index (BI) is a number derived from the rate of fire spread (SC) and the energy released (ERC) in the flaming zone. This, then, provides a rating of the difficulty of containment of a wildfire. The BI is linearly related to the length of flames at the head of the fire. It is calculated from the SC and ERC using the relationships developed by Byram (Byram 1959) for calculating flame length (Doering et al. 1978).

Yellowstone's step-up plan defines daily staffing classes (see Table 4) and fire management actions and is tied to the NFDRS Burning Index output as directed by NPS-18. The staffing classes are determined by graphing all BI predictions that have been archived in the AFFIRMS for the Mammoth fire weather station under fuel model G3P2 (NFDRS fuel model G, slope class 3, herbaceous class perennial, climate class 2). The staffing class levels are noted with the 90th percentile and a BI of 67 as the cutoff point between moderate fire danger and high fire danger. The normal funding for the fire management program is predetermined; it is calculated to be adequate for managing fire activity 90 percent of the days during the fire season. The remaining 10 percent of the fire season days are classified in the high to extreme fire danger range. Extra measures are taken to be prepared for fire activity during these periods (those actions are outlined in the step-up plan). The Burning Index is very sensitive to wind and often overpredicts daily fire

danger because most summer afternoons in Yellowstone are windy. Wind is the critical and necessary factor in large fire spread, and the Burning Index is a good indicator of probable worst-case conditions 24 hours in advance of an expected fire situation. Historically, human-caused fires originating within the park have not burned any significant acreage. Lightning-caused fires produce the most number of starts and burn the most acres. Therefore, the Lightning Activity Level (LAL) will be used as a factor in the step-up plan.

The Energy Release Component (ERC), which is related to the available energy (BTU) per unit area (square foot) within the flaming front at the head of a surface fire, is a widely used indicator of fire danger. The ERC calculations do not consider wind as a factor and can be used as a cross-reference indicator along with the BI. Since wind is not a factor in ERC calculations, the daily variation will be small, and the ERC numbers become relatively stable and may be used for planning decisions 24 to 72 hours ahead of an expected fire situation. The ERC is also a good indicator of drought conditions or long-term drying as dead and live fuel moistures are factors in the calculations.

The NFDRS provides the fire management staff with information that can be used in both short-term and long-term planning; it is not designed for nor is it adequate for predicting real-time fire behavior. Real-time fire behavior calculations can be estimated by four methods: (1) nomograms found in General Technical Report INT-30 (Albini 1976), (2) the TI-59/HP-71b hand-held calculators and the accompanying CROM chips and reference guides, (3) the BEHAVE program, an interactive computer program for fire behavior projections, and (4) the tables in S-390, Fire Behavior Field Reference Guide.

Real-time fire behavior predictions with area and perimeter map growth projections will be calculated for all new fire starts. Fire behavior predictions will also be calculated for all active wildfires and prescribed natural fires. "Active" is defined as a burning period in which fire perimeter growth is expected to increase by 10 percent or 10 acres, whichever is less. Current weather observations will be used, and spot weather forecasts will be requested when determined necessary, and utilized for predictions into the next burning period. These predictions will provide the fire management staff with the fire's current rate of spread, heat per unit area, flame length, fireline intensity, spotting distance, and the fire's area and perimeter in acres and chains (a measurement distance of 66 feet). This information will be used to complete the Fire Situation Analysis (FSA) and Prescribed Natural Fire revalidation.

Utilizing both the NFDRS and fire behavior predictions, the Yellowstone fire management staff will remain up-to-date on the current fire danger and fire behavior and will be able to make planning decisions for the duration of each fire.

F. Step-up Plan

Yellowstone's Step-up Plan is designed to reflect the preparedness actions the park will take to meet the predicted fire danger. As mentioned above, the NFDRS Burning Index (BI) is used to determine the staffing class level which has a corresponding set of actions that the park will

Table II: Burning Index and Staffing Classes

BURNING INDEX	STAFFING CLASSES
0 - 16	I
17 - 32	II
33 - 66	III
67 - 78	IV
79+	V

initiate to meet the potential fire danger. The Mammoth fire weather station and the designated fuel model G3P2 (NFDRS fuel model G, representing windthrown and bug-killed lodgepole pine; a slope class of 3, 41-55 percent; perennial grasses; and a climate class of 2, defined as receiving deficient rainfall in summer) are used to indicate the worst-case fire danger scenario in the park.

Adjective Classes: As an aid to fire prevention messages, Table 3 converts fire danger rating into five categories: Low (L), Moderate (M), High (H), Very High (VH), and Extreme (E).

Table III: Adjective Classes

IGNITION COMPONENT	1	2	3	4	5
0 - 20	L	L	L	L	M
21 - 45	L	L	M	M	H
46 - 65	L	M	H	VH	VH
66 - 80	M	M	H	VH	E
81 - 100	M	H	VH	E	E

Actions taken under Staffing Classes I - III are funded through the normal FIREPRO budget. Additional actions detailed under Staffing Classes IV - V can be supplemented by emergency suppression funds requested through the Regional Fire Management Officer. The Burning Index and associated Staffing Classes are listed below and detailed in Table 2.

Table IV: Step-up Staffing Plan

Staffing Class	Burning Index	Actions
I (Low)	0 - 16	<ul style="list-style-type: none"> * Normal pre-suppression operations. * Helitack crew on normal duty. * Fire weather stations activated. * Equipment in state of readiness. * Lookouts manned.
II (Moderate)	17 - 32	<ul style="list-style-type: none"> * Normal pre-suppression operations. * Aerial detection as necessary. * Helitack crew on normal duty.
III (High)	33 - 66	<ul style="list-style-type: none"> * Lookouts manned seven days per week. * Lookouts manned extra hours after lightning. * Helitack personnel on seven day coverage. * Fire dispatch staffed seven days per week. * Fire monitors on seven day coverage. * If Forecast LAL 5 or 6 or Holiday move to SL IV.
IV (Very High)	67 - 78	<ul style="list-style-type: none"> * Notify Region through Daily Situation Report. * Notify neighboring FMD's. * Notify neighboring Fire Dispatch Offices. * Helicopter on extended standby. * Check daily availability of smokejumpers. * Check daily availability of retardant aircraft. * Status of regional fire suppression resources. * Lookouts placed on extended hours. * Aerial detection following observed LAL 3 to 5. * Four district firefighters on call weekdays. * Eight district firefighter on call weekends. * Fire information disseminated to:
V (Extreme)	79 +	<ul style="list-style-type: none"> * Park Fire Committee members on standby. * Cancel five days and leave for Fire Staff: <li style="padding-left: 20px;">Fire Management Offices <li style="padding-left: 20px;">Assistant Fire Management Officer <li style="padding-left: 20px;">Helitack Foreman <li style="padding-left: 20px;">Helitack Crew <li style="padding-left: 20px;">Fire Monitors
		<ul style="list-style-type: none"> * Minimum of twelve district firefighters available for immediate within park dispatch. * Prohibit open fires in backcountry. * If LAL 5 or 6 or dry lightning is forecast, organize in-park 20 person crew

G. Fire Detection

The capability of detecting a wildfire is the key to all suppression activities in the park. All initial sightings of fires will immediately be reported via radio to the Fire Dispatcher (KOF 700 FOX) or to the Communication Center (KOF 700) after normal Fire Management Office hours. All pertinent information, such as location, size, fire behavior, fuel type, and proximity to structures or roads will be reported. All reported fires will be verified and investigated. The following detection methods will be used:

Fire Lookouts. Yellowstone will operate the three traditional lookouts (Mt. Washburn, Mt. Holmes, and Mt. Sheridan) from June 15 until September 30, weather conditions permitting. Pelican Cone Lookout will be operated depending upon funding. The lookouts will be manned seven days per week for the entire fire season from 0800 to 1700 hours. During periods of severe lightning storms, the duty hours will be extended as necessary.

Aerial Detection Flights. These flights will be scheduled after periods of severe lightning when the fire danger is in the "Extreme" category or when normal visibility from the lookouts is hindered by smoke. Only experienced personnel will be used, and a predetermined flight route will be established by fire management personnel using both the lookout reports of areas where intense lightning has occurred and the lightning detection occurrence map provided by the Bureau of Land Management.

Fire Detection Patrols. Park rangers on road patrol and backcountry rangers on horseback or foot will look for new fire starts as part of their normal patrol routine. These rangers are instructed to take fire reports from visitors and concession employees and relay the pertinent information to the Fire Dispatcher. The park ranger may be requested to investigate fire reports in their district if a reported fire cannot be confirmed by one of the lookouts.

Other Agency Detection. The Gallatin, Targhee, and Bridger-Teton national forests and Grand Teton National Park often conduct aerial detection flights over lands adjacent to Yellowstone. The smokejumpers stationed at West Yellowstone also conduct detection flights and often report fires seen in Yellowstone as they are on their way to fires on one of the national forests. The Yellowstone Fire Dispatch Office remains in close contact with area fire dispatchers and relays any information on new fires reported on other agency lands, as well as information regarding new fire starts in Yellowstone.

The business telephone numbers for reporting fires are listed in area phone directories and the Communication Center is operated 24 hours per day, 365 days per year. The business and home telephone numbers of all Region 1 fire management offices and personnel are listed in the Region 1 Mobilization Guide which is provided to all interagency cooperators, park concessioners and area sheriff's departments.

H. Fire Suppression

Suppression includes all actions intended to extinguish or limit the growth of fires. All fires that are not classified as prescribed (either natural or management-ignited) fires are classified as wildfires and will receive prompt, safe, and cost effective suppression action. Three suppression strategies are available to fire managers: confine, contain, and control (previously defined under Fire Management Strategies section). Selection of the most appropriate strategy will be based on threats to life and property, values-at-risk, other fire activity, and fire suppression resource commitments. The Fire Management Officer has the authority to dispatch park initial attack resources, while the Fire Committee will determine the appropriate suppression response on all extended attack fires. Fires that impact multiple agencies will be managed according to the GYA Memorandum of

Agreement (Appendix E).

Dispatch. Dispatching involves the receiving of a fire report, gathering pertinent information, assessing and analyzing the situation, and assigning fire management personnel to carry out the desired control action under the direction of the Fire Management Officer. The fire dispatcher will monitor suppression progress, relay information to fire management staff and the affected District Ranger, process requests for additional manpower and supplies, and order aircraft support as needed. Suppression personnel will remain in radio contact with the Fire Dispatch Office during all phases of the suppression operations and report any significant events or fire status change.

The Yellowstone fire dispatch operation is responsible for submitting daily situation status reports to the NPS Fire Management Office in Boise, Idaho, and to the Region 1 Coordination Center in Missoula, Montana. Daily check-ins and status of resources information are relayed to the dispatch office at the West Yellowstone Interagency Fire Center in West Yellowstone, Montana. During periods of extreme fire danger and shortages of resources, calls are also made to the Wyoming Interagency Dispatch Center in Cody, Wyoming; the Targhee dispatch office in Island Park, Idaho; the Grand Teton dispatch in Moose, Wyoming; and the Bridger-Teton dispatch in Jackson, Wyoming. Yellowstone's fire dispatch is linked to the national forests, including the Region 1 Coordination Center, via a Data General terminal. This allows Yellowstone to remain in contact with interagency cooperators at all times.

Requests for all support resources needed in fire and other emergency operations will be processed through the Fire Dispatch Office. A current list of qualified personnel, preapproved for initial dispatch by the Chief Ranger, will be maintained at the Fire Dispatch Office. Requests for interagency assistance will be processed through normal procedures, which include completing the Resource Order form. Dispatching requested resources for out-of-park assignment will be approved by the Chief Ranger after consultation with the Emergency Operations Specialist and the Fire Management Officer. For any additional personnel requested, the immediate supervisor and respective Division Chief will be contacted for approval.

Initial Attack. All fires declared wildfires will receive an immediate and aggressive initial attack response. The Fire Management Officer (FMO) will contact the affected District Ranger and dispatch the initial attack personnel. The Fire Management Officer will assign an Incident Commander and determine the appropriate suppression strategy to utilize. The FMO will keep the Chief Ranger and Emergency Operations Specialist informed and updated on the fire situation. The FMO will coordinate all suppression activity with the District Ranger and may request that district personnel initial attack a fire. The goal in all initial actions is to limit damage to values at risk, while minimizing the area burned and preventing escape of the fire.

An Incident Commander (IC) Type IV will be responsible for all actions taken on the fire. The IC will inform the FMO of the fire situation as soon as possible after arrival on scene. If the fire behavior and complexity continues to increase, the IC may be replaced by an Incident Commander Type III along with additional support personnel and supplies. The FMO is responsible for the selection of a replacement IC. If the fire threatens to exceed all initial attack capabilities, the Fire Management Committee will be convened. The fire has now moved into the extended attack stage.

Extended Attack. Extended attack occurs when a fire has not been contained or controlled by the initial attack forces. The extended attack continues until either the transition to a higher level incident management team is completed or the fire has been contained or controlled. The Escaped Fire Situation Analysis (EFSA) will be completed by the FMO when a fire escapes initial attack, and the incident management team will determine the most appropriate suppression strategy. This

analysis will be reviewed daily by the Fire Management Committee and updated as needed by the FMO. The current and predicted fire activity will be determined, management alternatives for suppression actions offered, the effects of suppression efforts analyzed, and specific direction to the Incident Commander provided.

Planning and preparation for suppression actions within Yellowstone have been formulated with the goal of establishing a fire management organization that can, with park staff, control 90 percent of all fires that start in the park. Control of the remaining 10 percent of fire occurrences may require assistance from the nearest available adjacent cooperating agencies and regional or national resources. If a fire exceeds or threatens to exceed park capabilities, additional resources will be ordered through normal dispatch procedures. The amount and type of assistance needed and requested will depend on the present and expected complexity of the fire situation. The Fire Complexity Assessment checklist will be completed when a fire escapes initial attack, and all necessary resources will be documented on a Resource Order Form (NFES-1470) and processed by the Northern Rockies Coordination Center.

When an Incident Management Team is assigned, the team will be briefed by the Superintendent (Agency Administrator's Briefing) and current IC. The team will be given a written delegation of authority and will have an Agency Administrator's Representative assigned as a staff member to the incoming IC. The delegation of authority will provide the IC with the Agency Administrator's priorities, specific restraints, and other guidelines necessary to carry out the EFSA. When the team has accomplished its assigned tasks, the fire will be transferred back to the park. A local Incident Commander will then be assigned, and a debriefing will be held by the departing team to provide for an orderly transition of command. The Superintendent will then conduct a closeout session that will include a performance evaluation of the departing team. The transition IC will then assume command at the agreed upon time, and the departing team will be demobilized.

Suppression Strategies. Three possible suppression alternatives were previously mentioned, but more detail is appropriate in this section. The three alternatives are confine, contain, and control. The decision as to which strategy or combination of strategies to implement in the suppression of a fire will be determined by the Fire Management Officer for routine fires that do not exceed initial attack. An EFSA will be prepared on all fires that escape initial attack.

Confine is defined as a suppression strategy that allows a fire to burn as long as it remains, or is predicted to remain, within predetermined natural boundaries until it is out. This alternative requires minimal suppression action. This alternative is used in areas having extensive natural barriers and low values at risk and under weather conditions that do not have the potential to carry the fire into areas where the fire is unwanted.

Contain is defined as a suppression strategy where a fire is restricted to a certain area by using natural or constructed barriers that stop the fire's spread under the prevailing and forecasted weather conditions until it is out. This alternative is used when values at risk are not as significant as those under the control alternative where the fire poses no threat to human life or property, where the fire cannot burn out of the park due to strategic natural barriers, and/or on fires where suppression actions may place firefighters in undue danger.

Control is defined as a suppression strategy where aggressive suppression tactics are used to establish firelines around a fire to halt its spread and to extinguish all hotspots until it is out. This alternative is used whenever there is a threat to human life, property, private lands, adjacent public lands, and critical natural or cultural resources.

The most appropriate suppression response will be chosen and specified by the Fire Management Officer on initial attack fires and by the Fire Management Committee on fires that escape initial attack efforts or pose a serious threat to human life, property, and other areas of concern. All three strategies require continuous observation of the fire's behavior and the involvement of the fire management staff through the entire course of the fire.

I. Minimum Impact Fire Suppression and Rehabilitation

Fire management activities within the park will be carried out in a manner that minimizes impacts to Yellowstone's natural and cultural resources. Minimum impact suppression tactics will be used and incorporated into the Agency Administrator's Briefing and Delegation of Authority to the incoming Incident Management Teams. Suppression teams will use methods and equipment commensurate with suppression needs and the chosen strategy of confine, contain, or control or a combination of those which will least alter the landscape or disturb park resources. Approximately 95 percent of Yellowstone is a proposed wilderness area and is managed as such. Minimum impact tactics (listed in NPS-19, Section III, Chapter 8, Exhibit 7) include, but are not limited to:

1. Use of water or fugitive retardant is preferred.
2. Firelines should be kept to the minimum width necessary to stop the fire's spread. Whenever possible, natural barriers should be utilized to avoid unnecessary fireline construction.
3. Cold trailing of the fire-edge rather than digging handlines is preferred whenever possible.
4. Wetline should be used in lieu of handline construction if water and pumps are available.
5. All firelines, spike camps, or other disturbances inside the park should be rehabilitated to maintain a natural appearance.
6. Tree felling should be minimized, especially in visually sensitive areas. Later, during rehabilitation efforts, the "slant cut" technique, which faces the cut away from view, or flush cutting stumps is preferred.
7. Trees, limbs, brush, and other debris should be scattered and not left in piles. This debris will be used in rehabilitation efforts by placing it over previously constructed firelines.
8. Protective tactics should be used in areas identified by the Cultural Resources Management Specialist as having cultural significance, either archeological or historical.
9. Protective tactics should be used in areas identified as being sensitive for natural resources.
10. The Incident Commander is charged with incorporating minimum impact tactics into the suppression efforts in all operational plans.
11. Heavy equipment, such as dozers, will not be used without approval by the Regional Director.
12. No vehicles should be driven off-pavement without the Superintendent's approval.

Rehabilitation will only be required where the impacts of the fire itself or the associated suppression actions are significant and can be mitigated. No rehabilitative action will be taken which will cause further damage to the environment. If the minimum impact suppression actions outlined above are used, then only minimal rehabilitation will be necessary. Proper location of firelines will avoid the

need for the felling and bucking of trees as well as the use of wetlines. When no human life or property is threatened, it is acceptable to use natural barriers for firelines even if more acres will be burned. Efforts to rehabilitate the direct impacts of fire suppression activities will begin as soon as possible, at times even before the fire is declared out. This will allow the park to utilize assigned resources and potentially reduce rehabilitation costs.

To minimize the introduction of exotic vegetation into Yellowstone, burned areas will not be reseeded. As discussed in the Fire Effects section, residual seed and sprouting from the surviving below-ground plant parts will provide natural revegetation.

J. Fire Records and Reports

Fire records have been kept in one form or another since the establishment of Yellowstone. The early records were incorporated into the annual Superintendent's report in narrative form. All yearly records through 1969, including fire occurrence, fire weather, fire equipment inventories, fire photographs, fire and lookout logbooks, and fire map atlases are currently stored in the museum archives. The records for the years 1970 - 1991 are stored in the Fire Management Office and are under the responsibility of the FMO. During the fire season, daily fire situation reports are submitted by 1000 hours, to the NPS Branch of Fire Management in Boise, Idaho, and to the Northern Rockies Coordination Center in Missoula, Montana.

Fire weather information is relayed to the Fire Management Office on a daily basis during the fire season where it is entered into the AFFIRMS by 1400 hours each day and is automatically archived into the National Fire Weather Data Library. This information is used to generate the NFDRS outputs which are calculated each day at 1600 hours to determine the staffing class for that evening and the next day and to evaluate the potential fire danger in Yellowstone. Fire weather forecasts are retrieved twice daily, once at 0930 hours and again at 1600 hours, and used in conjunction with the NFDRS outputs for repositioning resources and evaluating expected fire danger. The FMO is responsible for the use and storage of these reports.

Each wildfire, prescribed natural fire, prescribed burn, and assist response to the interagency community is assigned a fire number. This action requires the preparation of an Individual Fire Report (DI-1202). These reports are submitted in writing by the FMO to the Chief Ranger for approval and are then entered into the NPS Fire Management Computer System for permanent archival. The FMO is responsible for the entry and accuracy of these reports.

Fire Situation Analysis. Within the first 72 hours of a fire, a Fire Situation Analysis (FSA) will be completed for each fire declared a prescribed natural fire. Part I of the Fire Situation Analysis (FSA) will be updated and revalidated daily. The information will be reviewed by the Fire Management Committee, and the recommendation of the Committee will be incorporated for each fire. The FMO is responsible for completing and filing the report with all other information regarding that particular fire.

Annual Reports. The FMO is responsible for preparation of annual reports detailing fire and aviation activity. This report will be submitted to the Chief Ranger for final approval. A copy will remain on file in the Fire Management Office.

Fire Qualifications. The FMO will be responsible for maintaining current records of all qualified red-carded personnel in the park. These records will be used for dispatch purposes to assign qualified and physically fit personnel to positions on a fire. These records will be updated after each fire season.

IX. MANAGEMENT-IGNITED PRESCRIBED FIRE/PRESCRIBED BURN PROGRAM

Management-ignited prescribed fires are used as a tool to achieve management goals. Prescribed fire will reflect and support resource management objectives as stated in the Resource Management Plan. Prescribed fire may also be used in conjunction with mechanical hazard fuel reduction in order to burn fuels that accumulate from these fuel reduction operations. Research burning may also be conducted when it is determined necessary for accomplishment of research project objectives.

Actions included in the prescribed burn mobilization program include: the park's selection and prioritization of prescribed burns to be carried out during the year, prescribed burn plans, burn prescriptions, burn operations, documentation and reporting, and burn critiques. Measures to ensure successful implementation of prescribed burns will include: (1) burn plans prepared by a qualified Prescribed Fire Manager (PFM)/Prescribed Burn Boss (PBB); (2) burn plans reviewed by a qualified PFM/PBB to verify the proposal with regard to fire behavior, fuel conditions, and safety; (3) prescribed burns conducted by a qualified PBB with qualified support personnel to ensure success; (4) adequate number of holding crew personnel on hand to monitor, chase hot spots, mop-up, and serve as the initial attack crew in case of the fire's escape; and (5) burn plans approved and signed by the park Superintendent. The park reserves the option to utilize an interagency team approach for complex burns carried out on the boundaries and close to developed areas or burns of large acreages. The most highly qualified and experienced personnel in the regional interagency community would be requested to serve on this team.

A. Annual Management-Ignited Prescribed Fire Program

Prescribed burning may be used in all three of Yellowstone's fire management zones to achieve resource management objectives as outlined in this plan. The annual prescribed burn program will be prepared by the Fire Management Officer with assistance from the Fire and Emergency Operations Specialist and Assistant Fire Management Officer. The program will detail all burns planned for the year, specifying objectives to be accomplished. The Chief Ranger will review and submit this program plan to the Superintendent for approval. The plan will then be reviewed and approved at the regional level.

The Fire Management Officer will recommend a Prescribed Burn Boss for each planned burn. The Prescribed Burn Boss will conduct a field reconnaissance of the proposed burn location with members of the Fire Management Committee and Resource Management staff to discuss objectives and special concerns and gather all necessary information to write the burn plan. After completing the reconnaissance, the Prescribed Burn Boss and Fire Management Officer will write a prescribed burn plan.

B. Prescribed Burn Plan

The prescribed burn plan is a site specific action plan which describes the purpose, objectives, prescription, and operational procedures needed to prepare and safely conduct the burn. The treatment area, objectives, constraints, and alternatives will be clearly outlined, and no burn will be ignited unless all prescriptions of the plan are met. The factors to be considered in preparing a prescribed burn plan are contained in NPS-18, Section III, Chapter 5, Exhibit 3.

C. Prescribed Burn Objectives

The overall fire management program objective in Yellowstone is to reduce interference by man in the ecosystem. To promote the prescribed natural fire program, park management may use prescribed burns to create fuel breaks (mosaic patterns) around structures inside and adjacent to the park and along boundary areas (thus reducing the threat of unwanted fire).

Prescribed Burn Bosses will be assigned, burn plans will be written and approved, and burns will be conducted only under the clearly specified prescription parameters. Prescribed burning may be conducted anytime during the year, depending upon when the area (unit) to be burned comes into prescription. The preferred time for prescribed burning would be during times of low visitation.

D. Prescribed Burn Operations

The Fire Management Officer will designate a qualified Prescribed Burn Boss and other necessary burn team members to conduct the burn. Yellowstone will maintain on its staff the qualified personnel necessary to conduct the planned prescribed burns. This will be accomplished through training, burn experience, and recruitment.

The Prescribed Burn Boss will fill all required positions necessary to conduct the burn with qualified personnel including Firing Boss, Holding Boss, and Ignition Boss. All personnel listed in the burn plan must be available for the duration of the burn or the burn cannot be carried out.

Weather and fuel moisture conditions must be monitored closely in planned burn units to determine when the prescription criteria is met. A weather station will be set up in the burn unit and equipped with a hygrothermograph, maximum and minimum thermometers, fan psychrometer, 10-hour fuel moisture sticks, and a precipitation gauge. Weather data will be gathered at least 30 days prior to conducting the burn so that accurate calculations of the 100- and 1000-hour timelag fuel moistures, energy release component, ignition component, spread component, and burning index can be obtained. Fuel moisture samples of 10-, 100-, and 1000-hour down and dead logs and of live plants will be collected each week, weighed, oven dried, and percent moisture contents calculated to help determine when the prescription criteria are met.

When all prescription criteria are within the acceptable range, the Prescribed Burn Boss (PBB) will select an ignition date based on current and predicted weather forecasts. All personnel and equipment will be assembled one day prior to the planned ignition date. A thorough briefing will be given by the PBB, and specific assignments and placement of personnel will be discussed. A current spot weather forecast will be obtained on the day of ignition, and all prescription elements will be rechecked to determine if all elements are still within the approved ranges. If all prescription elements are met, a test fire will be ignited to determine on-site fire behavior conditions as affected by current weather. If conditions are not satisfactory, the test fire will be suppressed, and the burn will be rescheduled. If conditions are satisfactory the burn will continue as planned.

The Prescribed Burn Boss or one of the Burn Team members will be qualified at the Incident Commander Type III level in the event of an escaped prescribed burn. If the prescribed burn escapes the predetermined burn area, all further ignition will be halted and suppression efforts, as discussed in the preburn briefing, will be initiated. The Chief Ranger and Fire Management Officer will be notified immediately of any control actions on a prescribed burn. If the burn exceeds the initial suppression efforts, the burn will be declared a wildfire and completely suppressed. An EFSA will be completed and additional personnel and resources ordered as determined by the Incident Commander. If the fire continues to burn out of control, an incident management team may be requested to assume command of the fire.

E. Documentation and Reporting

All prescribed burn forms will be completed as outlined by the Prescribed Burn Boss. A fire monitoring team will be assigned to collect all predetermined information and complete all necessary forms prior to, during, and after the burn. All records will be archived in the park's fire records and stored in the Fire Management Office for future use and reference.

The Prescribed Burn Boss will prepare a final report on the burn for the Chief Ranger. Information will include a narrative of the burn operation, a determination as to whether or not the objectives were met, weather and fire behavior data, a map of the burn area, photographs of the burn, number of hours worked, and final cost of the burn.

F. Prescribed Burn Critique

The Fire Management Committee, headed by the Chief Ranger, will critique each prescribed burn. A report detailing the actual burn will accompany any recommendations or changes deemed necessary in the program. This report will be submitted to the Superintendent and Regional Fire Coordinator for review. A post-season critique of the fire management program, including the prescribed burn program, will be held each year by the Fire Management Committee.

X. PRESCRIBED NATURAL FIRE PROGRAM

A. Objectives

Prescribed natural fire (PNF) is defined as fire that is ignited by natural means (usually lightning) that is permitted to burn under specific environmental conditions, in preplanned locations, with adequate fire management personnel and equipment available to achieve defined objectives (see NPS-18, Section IV, p. 10).

The prescribed natural fire management program includes all operational procedures necessary to manage prescribed natural fires in Yellowstone National Park. The objective of Yellowstone's prescribed natural fire program is to allow all PNFs to burn unhindered within predetermined prescriptions. Where cooperative agreements are in force, fires may be allowed to burn across management boundaries as long as they remain within mutually acceptable prescriptions.

Fires declared prescribed natural fires by the Fire Management Committee will be continually monitored and evaluated from the time of discovery until the time the fire is officially declared out. This is to ensure that each fire remains within prescription. Qualified fire monitors will be assigned to each active PNF to provide accurate fire weather, fire behavior, and fuels information. Active status is defined as a burning period in which fire perimeter growth is expected to increase by 10 percent or 10 acres, whichever is less.

Public information is a vital component of the PNF program. The Public Affairs Office will play an important role in disseminating accurate and timely fire updates to the public via the various news media.

Prescribed natural fires that exceed, or are predicted to exceed, prescription criteria will be declared wildfires and be suppressed under the appropriate suppression strategy (as defined in NPS-18, FSA, Part II). Once a fire is declared a wildfire, it will never be reclassified as a prescribed natural fire.

B. Prescribed Natural Fire Management Decisions

The decision flow charts and criteria for designating and evaluating natural fire starts are described in Table 5. Prescription elements for prescribed natural fires in both the Conditional and Prescribed Natural Fire zones are detailed in Tables 6 and 7. These prescriptions were derived from a detailed analysis of daily fire weather, fire danger indices, and actual fire perimeter growth under specific fire behavior and weather conditions compiled for the years 1972 through 1988. The intent of these prescriptions is to allow fire to play its ecological role in the park to the greatest extent possible. Prescribed natural fires will be allowed to continue burning if the weather, fire danger indices, projected fire behavior, and acceptable perimeter will not be exceeded.

Initially, when a fire starts and is declared a prescribed natural fire, the prescription criteria outlined in Tables 6 and 7 will be used to determine if that fire is within prescription or not. Lightning-caused fires that fall within these prescriptions will be declared prescribed natural fires. Lightning-caused fires that exceed these prescriptions will be declared wildfires, and the appropriate suppression actions will be taken.

Vegetation in the park normally cures near the end of August each year. When the mathematical fuel models are described as "cured," the daily mathematical fire danger indices react immediately with the 100- and 1000-hour fuel moistures lowering these values approximately 1 percent and raising the ERC and BI values, thereby elevating the overall fire risk to more extreme levels. Due to this phenomenon, the shorter days, cooler temperatures, generally higher relative humidities, and

Table V: Decision Flow Chart

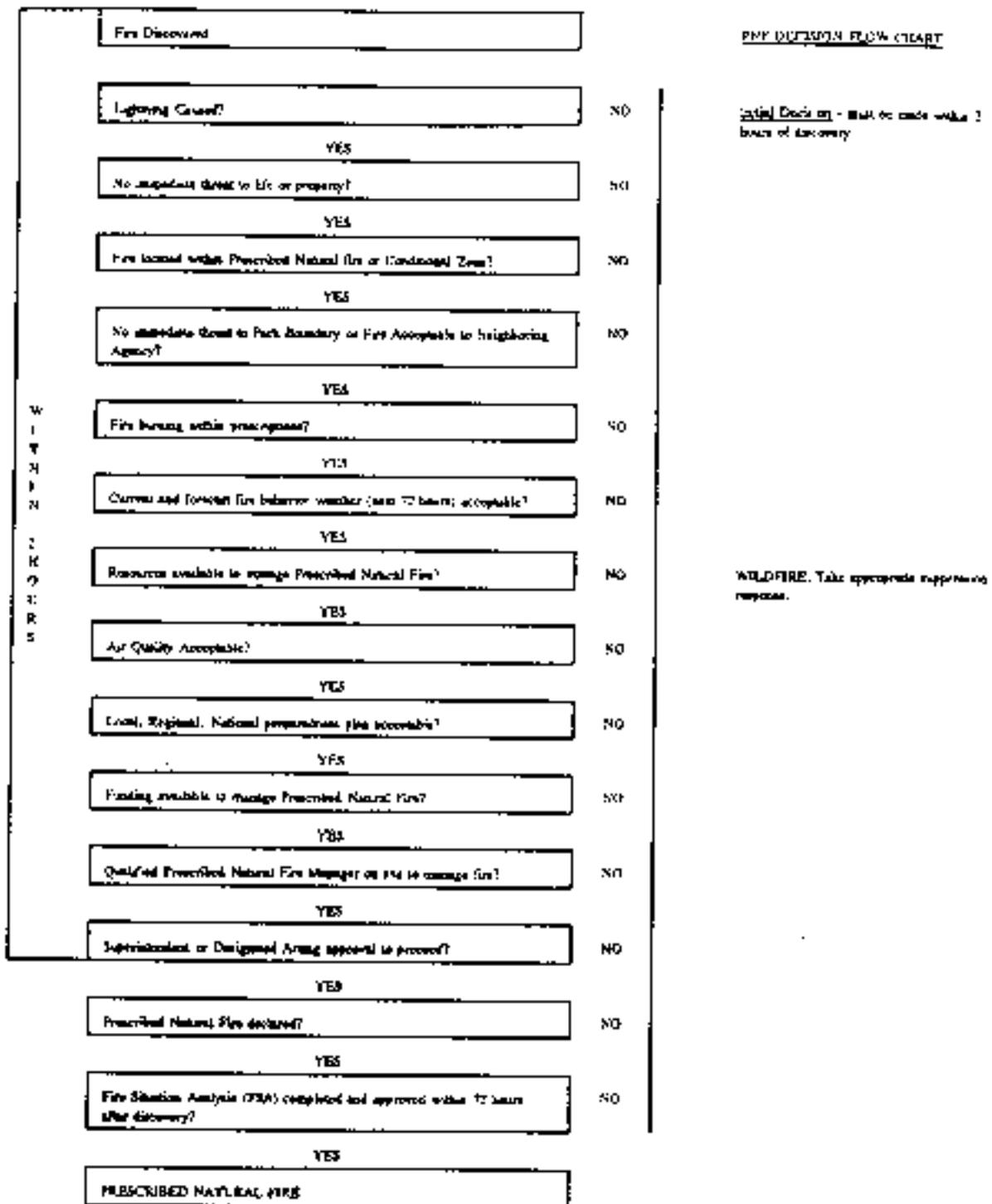
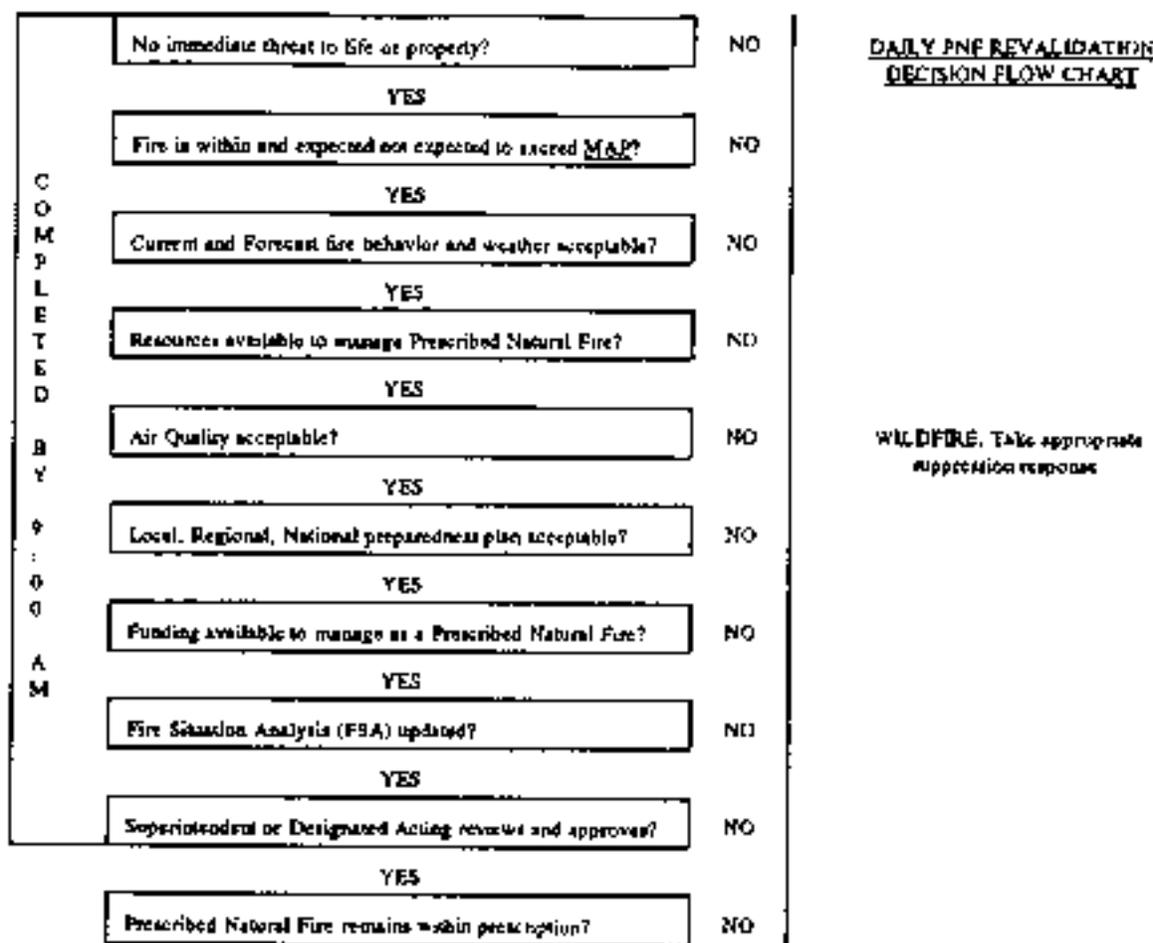


Table VI: Daily Prescribed Natural Fire Revalidation Decision Flow Chart



the approaching fall precipitation, the actual fire danger is not as extreme as the fire danger indices indicate. For these reasons, after fuels are cured the prescription limits for lightning-caused fires that occur in the Conditional and Prescribed Natural Fire zones will have slightly higher initial ERC and BI levels and lower 1000-hour fuel moisture content levels. The intent is to allow PNFs to continue burning if they are predicted to remain within an acceptable perimeter.

Prescribed Natural Fire Management Decisions

1. The ignition of each new fire will be determined and its exact location plotted. All human-caused fires will be declared wildfires and immediately suppressed. All lightning-caused fires in the Prescribed Natural Fire and Conditional zones will be considered as potential PNF candidates.
2. The Fire Management Committee will meet and conduct an evaluation of each new lightning-caused fire in the Prescribed Natural Fire and Conditional zones. This initial evaluation will be completed within two hours.
3. All fires initially approved as PNFs will be assigned to a Prescribed Fire Manager (PFM) for

the duration of the fire. The PFM will initiate the monitoring and information gathering process to complete the Fire Situation Analysis (FSA).

4. The FSA and Prescribed Fire Complexity Analysis will be completed within 72 hours. This will include a determination of the area of the maximum allowable perimeter for each PNF.
5. Monitoring of each PNF will continue, with the FSA, Part I, updated daily. This will include daily revalidation that the PNF will continue to burn within prescription. The FSA will be signed by the Superintendent or his/her designated representative.
6. A fire will either be declared out or declared a wildfire.

PRESCRIPTIONS

A newly detected lightning-caused fire will be designated a prescribed natural fire in the Conditional Zone of Yellowstone National Park if all the conditions listed below are met.

Table VII: Prescription Parameters for Prescribed Natural Fires in the Conditional Fire Zone

PRESCRIPTION ELEMENT	CONDITION	
	PRIOR TO CURING	AFTER CURING
Burning Index	< 60 Mammoth Area < 50 Mt. Sheridan Area	< 65 Mammoth Area < 55 Mt. Sheridan Area
Energy Release Component	< 55 Mammoth Area < 50 Mt. Sheridan Area	< 60 Mammoth Area < 55 Mt. Sheridan Area
Drought Index 1000 Hour TLFM	> 12% Mammoth Area > 14% Mt. Sheridan Area	> 11% Mammoth Area > 13% Mt. Sheridan Area

A newly detected lightning-caused fire will be designated a prescribed natural fire in the Prescribed Natural Fire Zone of Yellowstone National Park if all the conditions listed below are met.

C. Prescribed Natural Fire Mobilization

The factors to consider in managing a prescribed natural fire program include: the complexity of the fuels, fire behavior, potential for escape, values at risk, fire duration, smoke, and air quality. The personnel required to manage the prescribed natural fire program in Yellowstone include a Fire

Table VIII: Prescription Parameters for Prescribed Natural Fire in the Prescribed Natural Fire Zone

PRESCRIPTION ELEMENT	CONDITION	
	PRIOR TO CURING	AFTER CURING
Burning Index	< 70 Mammoth Area < 60 Mt. Sheridan Area	< 75 Mammoth Area < 65 Mt. Sheridan Area
Energy Release Component	< 65 Mammoth Area < 60 Mt. Sheridan Area	< 70 Mammoth Area < 65 Mt. Sheridan Area
Drought Index 1000 Hour TLFM	> 10 $\frac{1}{2}$ Mammoth Area > 11 $\frac{1}{2}$ Mt. Sheridan Area	> 9 $\frac{1}{2}$ Mammoth Area >10 $\frac{1}{2}$ Mt. Sheridan Area

Behavior Analyst, a Prescribed Fire Burn Boss I, and five fire monitors qualified at the Fire Behavior and Weather Specialist II level. These personnel gather fire behavior, weather, and fuel moisture information to determine whether each PNF will remain within prescription. In the event of an escaped PNF, the Fire Management Committee will determine the necessity of order an Incident Management Team. Any order will be place through normal dispatch channels.

D. Fire Monitoring

All prescribed natural fires and prescribed burns will be monitored by qualified personnel under standards identified in this plan. The Prescribed Fire Manager will assign fire monitors. Fires will be monitored either on-site, by the three fire lookouts, or by aerial overflights.

The level of monitoring will be determined by the current and predicted fire behavior activity. Active prescribed natural fires will have a fire monitoring team assigned. The lead person on this team will be qualified at the Fire Behavior and Weather Specialist II level. When fires are active, on-site fire monitors will take fire weather variables on an hourly basis, estimate fire behavior parameters, note fire effects, conduct down and dead fuel inventories, collect vegetative samples (both dead and live) for fuel moisture content percentages, and take photographs of the fuel type and fire behavior. Prescribed natural fires that are inactive or in size class A (0 - 1/10 acre in size) and are predicted to remain in this size class, may be monitored by a lookout or aircraft overflight.

Monitoring Objectives

Yellowstone has developed a field monitoring guide which is located in Appendix I. This information will allow the Fire Management Committee to stay apprised of the fire situation at all times and update its evaluation of the fire each day to ensure protection of human life and property both inside and outside of the park.

The specific objectives of monitoring are:

1. To gather daily fire weather, behavior, and growth information for update of the FSA.
2. To determine if the fire is burning within prescription or is predicted to exceed any of the prescription criteria.
3. To provide information that will ensure protection of human life, property, and cultural resources.

E. Fire Reporting

A fire monitoring report will be prepared daily and will serve to update and revalidate the Fire Situation Analysis (FSA). This report will become part of the final fire documentation package.

F. Fire Situation Analysis/Escaped Fire Situation Analysis

A Fire Situation Analysis (FSA) will be completed within 72 hours after a fire is detected and updated each day in a formal manner. Multiple PNFs that are inactive, class A in size, or in the same geographic area and in similar fuels, may have a common FSA prepared during the first burning period. The FSA for these multiple fires will be revalidated daily with all pertinent information updated as necessary. The Superintendent or his/her designated representative will review and sign the updated FSA.

An Escaped Fire Situation Analysis (EFSA) will be prepared by the FMO if a PNF exceeds prescription and is declared a wildfire. This document will be reviewed by the Fire Management Committee and will be used to determine the suppression actions to be taken in the management of the escaped fire. The FSA and EFSA forms are located in Appendix H.

G. Fire Effects Monitoring

Past and current projects have established research methods and techniques to determine short- and long-term fire effects in Yellowstone. Fire effects research has been conducted and is continuing in the following areas: wildlife, fisheries, vegetation, fuel moisture sampling, soils, landscape patterns, water quality, and air quality. Copies of fire effect publications and information on fire effect projects may be obtained from the Yellowstone Research Office. An updated vegetative fuels map was prepared in 1989.

H. Drought Evaluation

Yellowstone has compiled and analyzed long-term drought conditions by utilizing 1000-hour fuel moisture contents. The 1000-hour fuel moisture data is obtained by collecting down and dead logs, three to eight inches in diameter at predetermined locations in Yellowstone. These logs are weighed and then oven-dried to determine the exact fuel moisture content (in percent). This data is then correlated against the 1000-hour moisture content generated by the fire weather observation inputs into the NEDRS. When the 1000-hour fuel moisture content drops to 12 percent, fires will begin to spread in the surface layer fuels. When the 1000-hour fuel moisture content drops to 10 percent, torching and crowning of trees will occur. When the 1000-hour fuel moisture content drops below 10 percent, fires will spread independently through tree crowns, experience long-range spotting, and burn large acreages, as long as the fire is driven by strong winds.

Yellowstone also monitors the Palmer Drought Index monthly maps produced by the Boise Fire Weather Office and began calculating the Keetch-Byram Drought Index in 1988. These two indexes will be carefully monitored to provide park staff with additional information on evaluating drought conditions.

I. Budget/Fiscal Management

FIREPRO is the fire management budget planning and programming system developed by the National Park Service. FIREPRO is based on the following principles of the fire management program:

(1) Permanent and seasonal staffing is based on the workload and complexity of the park fire program.

(2) Normal fire year:

(a) The normal wildfire year is defined as the year with the third highest number of wildfires in the past ten years of record.

(b) The normal prescribed natural fire year is defined as the year with the third highest number of acres burned in the past ten years of record.

(c) The normal prescribed burning year is defined as the average number of acres burned in the past ten years of record.

Funding for FIREPRO activities is provided through the Department of Interior firefighting account (P.L. 101-121, Department of the Interior and Agencies Appropriation Act, 1990), which may be supplemented by the emergency authority provisions of Section 102 of the Department of the Interior. FIREPRO funds are funds which are distributed to parks and regions by the Branch of Fire Management.

The following FIREPRO-funded activities will be managed through the use of Work Order Projects (WOP): prescribed natural fire monitoring and management projects, hazard fuel reduction projects, other management-ignited prescribed fire projects, step-up plan actions (emergency presuppression), wildfire suppression actions, and emergency rehabilitation actions. Other fire management activities will be funded through Annual Operating Programs (AOP). Funds for emergency presuppression and wildfire suppression are designated for step-up plan and suppression actions and may not be used to manage prescribed natural fire activities.

The Branch of Fire Management, acting through the NPS Washington Budget Office, will establish funding and personnel staffing levels for national and regional offices and individual park units.

J. Information and Interpretation

Public awareness and acceptance of the prescribed natural fire program is of utmost importance in Yellowstone. The park will prepare a supplemental handout explaining the overall fire management program in Yellowstone, including information on prescribed natural fire and prescribed burning, which will be distributed at all entrance stations and visitor centers.

The Interpretive staff will continue their efforts in informing the public about National Park Service and Yellowstone philosophy of fire. This may include having on-site interpretive personnel at a fire to answer specific questions regarding fire or leading groups of visitors to a vantage point from which to watch a fire. Slide presentations, video tape presentations, and interpretive talks will address the fire management program and explain the role of fire in the Yellowstone environment. The fire management staff will provide the following information, in a timely manner, about all fire activity to the Public Affairs and Interpretation offices for dissemination:

1. Fire location, behavior, and growth.
2. Fire management actions being taken on the fire.
3. Commitment of park personnel and equipment, including commitment of park resources to any fire burning outside of the park.

4. Restrictions and closures within the park.
5. Fire impacts, inside and outside the park, on public and private facilities and services.
6. Potential fire effects.

XI. AIR QUALITY / SMOKE MANAGEMENT GUIDELINES

National Park Service fire management activities which result in the discharge of air pollutants (e.g., smoke, carbon monoxide, and other pollutants from fires) are subject to, and must comply with, all applicable federal, state, interstate, and local air pollution control requirements, as specified by Section 118 of the Clean Air Act, as amended (42 USC 7418). It is not the primary intent of the Clean Air Act to manage the impacts from natural sources of impairment (i.e., prescribed natural fires). Smoke from these fires is an inevitable by-product. Fires are not considered point sources of emissions, but tend to be spatially distributed singular events, and temporary impacts to visibility and visitor enjoyment must be recognized, expected, and managed. This may include temporary closures or warnings during the progress of management approved, ecologically essential fires. These fires are termed ecologically essential because fire plays a principle, and in some cases a dominant role, in maintaining the integrity of park resources.

Yellowstone National Park is designated as a Class I airshed under the Clean Air Act and is required to protect air quality values, including visibility. The Act requires the Environmental Protection Agency (EPA) and individual states to develop long-term strategies to achieve national visibility goals for Class I areas. Yellowstone is bound by this legal obligation to protect air quality and related values in the park from adverse effects. These effects are measured by six air pollutants: carbon monoxide, nitrogen dioxide, sulfur dioxide, lead, ozone, and particulate matter.

The park monitors baseline visibility, particulates, Sox (sulfur oxides), nitrogen dioxide, total suspended particles, carbon monoxide, and ozone as well as meteorological conditions in the Lake and Mammoth areas. A transmissionometer is located at Lake to monitor trends in visible air quality. A National Atmospheric Deposition Program site is located at the Tower Ranger Station.

Smoke from prescribed natural fires may impact visual opportunities. Smoke from these fires is part of the natural ecosystem and will be permitted under less-stringent application of the guidelines listed below. Smoke generated by management-ignited prescribed fires will be managed to minimize degradation of air quality and visibility. The park's guidelines for smoke from a management-ignited prescribed fire are:

1. All burn plans will have clear objectives and will monitor impacts of smoke on the human and natural environments.
2. Prescribed burns ignited in proximity to structures will only be ignited during periods of low visitation and if the prevailing winds will carry the smoke away from the structures.
3. Current and predicted weather forecasts will be utilized along with test fires to determine smoke dispersal.
4. Smoke dispersal will be visually monitored on a continuous basis at set intervals during the course of all prescribed burns. If air quality standards are exceeded or smoke creates a hazard or nuisance, especially in or near smoke sensitive areas, the prescribed burn will be extinguished.
5. An Air Quality Monitoring Plan will be developed and implemented for management-ignited prescribed fires larger than 100 acres and expected to last for more than three days.
6. When management-ignited prescribed fires are conducted, notification will include the states of Wyoming, Montana, and Idaho; the U.S. Forest Service; local communities that may experience smoke; park staff; park concessioners; and park visitors.

All management-ignited prescribed fires will be approved and permitted as required by the Wyoming Department of Environmental Quality, Air Quality Division (WDEQ/AQD). Section 12 of Wyoming's air quality regulations prohibits activities that would violate the Wyoming Ambient Air Quality Standards for total suspended particulates. The U.S. Forest Service, Wyoming AQD, and the Bureau of Land Management have developed a computer model to estimate the possibility of a management-ignited prescribed fire exceeding air quality standards. Yellowstone will use this model, the Simple Approach Smoke Estimation Model (SASEM), to determine smoke impacts, amounts of smoke to be emitted, and potential locations that may be affected prior to igniting any fire. The state of Wyoming will evaluate this information and issue a burning permit if the emissions are determined to be within the acceptable parameters for maintaining air quality. No standards or restrictions regarding smoke emitted from prescribed natural fires have been set by the state of Wyoming.

Yellowstone has developed a Cooperative Smoke Management Plan with the state of Montana regarding smoke management and maintenance of air quality. This agreement establishes guidelines for management-ignited prescribed fires. As a signatory to this agreement, Yellowstone is granted an annual air quality permit. This permit requires Yellowstone to abide by the requirements and parameters established for conducting management-ignited prescribed fires. The park is also required to suppress fires if any of the parameters in the burn plan are being exceeded, or are predicted to be exceeded. No standards or restrictions regarding smoke emitted from prescribed natural fires have been set by the state of Montana.

XII. FIRE RESEARCH AND MONITORING

Research is a necessary component of the fire management program in Yellowstone. Research on the park's fire history has evaluated the natural role of fire in the Yellowstone ecosystem. This research was the foundation for the prescribed natural fire program begun in 1972. Fire research is conducted by, or is under the guidance of, the Research Division. Research on fire effects continues to be conducted on vegetation, fuel moisture of 1000-hour fuels, wildlife, fisheries, water quality, air quality, soils, and plant succession. Many projects have been undertaken in the aftermath of the 1988 fires and will provide valuable information about the effects of such large magnitude fires. This research will be analyzed and used in the fire management decision-making process.

XIII. PUBLIC SAFETY

Yellowstone National Park's fire management program is dedicated to ensuring the safety of each visitor and all residents and private property adjacent to the park's boundary. The Superintendent may close all of the park or a portion of it (including roads and trails) when either wildfire or prescribed natural fire poses an imminent threat to public safety.

The park will implement a notification system to inform visitors of all fire activity on a daily basis through normal communication channels. A fire activity report will be updated daily, or when significant changes warrant, in order to inform park personnel of any potential threat. Areas of fire activity will be clearly signed at trailheads and along roadways, and backcountry personnel will inform visitors obtaining permits for backcountry use of the exact location of fire activity. Residents adjacent to the park will be immediately notified by law enforcement personnel of any fire which poses the threat of burning outside the park's boundaries.

XIV. PUBLIC INFORMATION AND EDUCATION

A. Information

Dissemination of information concerning fire activity will be the responsibility of the Fire Management Officer through the Public Affairs Office. The Public Affairs Office will contact the news media and provide pertinent information. This information will be made available to all entrance stations, campground offices, the visitor service office, visitor centers, and park personnel through normal communication channels. Notification of cooperators will be accomplished through the Fire Management Office.

B. Education

Efforts to educate the public about the fire management policy will be handled at the national level through normal channels and through the Interpretation Division at the park level. Pamphlets will be handed out to each visitor and will be available at each visitor center and campground. Interpreters will prepare routine programs on the park's fire management program and explain the role of fire in Yellowstone's ecosystem.

XV. ARCHEOLOGICAL / CULTURAL / HISTORICAL RESOURCES

A. Archeological Resources

The Cultural Sites Inventory for Yellowstone National Park lists approximately 550 prehistoric and historic archeological sites (National Park Service, Midwest Archeological Center 1990). Because only 1 percent of the park has been intensively surveyed, it is highly likely that there are many unknown archeological sites within the park.

The Fire Management Officer (FMO) will be responsible for ensuring the consideration and protection (as necessary) of archeological sites in the fire management planning process. The FMO will work with the Cultural Resources Management Specialist (CRMS) to identify known sites or areas of archeological significance, to identify archeological sites that may be affected by fire and/or fire suppression activity, and to identify areas with a likelihood of having currently unknown archeological sites.

The Cultural Resources Management Specialist will be notified of all fire activity in the park to determine if any sites are in the path of the fire. In areas where suppression efforts are to occur, archeological surveys will be conducted in cooperation with the Cultural Resources Management Specialist.

B. Ethnographic Resources

The ethnographic record for Yellowstone National Park is incomplete. What little is known, however, indicates that some Native American myths and ethnohistoric reconstructions regard Yellowstone Lake and the immediate vicinity as ethnic homelands (finalized Archeological Work Plans for Yellowstone National Park, Rocky Mountain Region 1991). Historically, the Crow, Shoshone, Bannock, Nez Perce, Blackfeet, and Gros Ventre were known to have visited the park. The Shoshone, a group of the Shoshone, occupied portions of the park year-round during the first half of the nineteenth century. At this time, no ethnographic resources or resource areas have been identified in Yellowstone. As information is added to the ethnographic record, ethnographic resource areas may be identified that would need to be considered in reference to wildland fire and suppression activities. The Fire Management Officer is then responsible for ensuring that these resources are considered and protected (as necessary) in the fire management planning process. Planning efforts will be coordinated with the Cultural Resources Management Specialist.

C. Historic Structures

Yellowstone National Park has a number of significant historic structures. The List of Classified Structures lists 952 historic structures; 553 of these structures have been determined eligible for or entered on the National Register of Historic Places, the other 399 have not been evaluated for eligibility. The majority of these historic structures are located within the six historic districts and developed areas. There are also historic structures located away from developed areas, and these include backcountry patrol cabins, fire lookouts, and interpretive kiosks. Historic structures that are eligible for or listed on the National Register as well as historic structures that have not been evaluated for the National Register must be considered in the fire management planning process. (Structures that have been determined ineligible for the National Register do not need to be considered.)

The FMO will work with the Cultural Resources Management Specialist to identify the historic structures that need to be considered in the fire management planning process. The Fire Management Officer will then be responsible for ensuring the consideration and protection (as

necessary) of these historic structures.

D. Cultural Landscapes

At this time, no cultural landscapes have been identified in Yellowstone National Park. The Historic Resource Study, currently in progress, will identify potential cultural landscapes in Yellowstone National Park. After these cultural landscapes are identified, they will be evaluated for eligibility to the National Register. If they are determined to be eligible to the National Register, they will need to be considered and protected (as necessary) during wildland fire or suppression activities. Working with the CRMS, the FMO is responsible for considering these landscapes in the fire management planning process.

E. Collections

Yellowstone National Park's museum collections include a diverse range of 19,000 natural and cultural objects. These include paintings, pencil sketches, Native American objects, archeological artifacts, historic objects, and a herbarium collection. Objects which are not currently in the collection but are considered significant include historical furnishings and vehicles, a photographic collection, rare books, and natural resource specimens. Yellowstone National Park's archives contain 700 linear feet of irreplaceable historical documents. The Research Library contains 8,000 reference titles and manuscripts. The Fire Management Officer is responsible for ensuring that these identified collections, significant objects, archives, and the library are considered and protected (as necessary) in the fire management planning process. Coordination of planning efforts will occur with the park archivist/historian and the park curator.

XVI. FIRE CRITIQUES AND ANNUAL PLAN REVIEW

A. Fire Critiques

Fire reviews will be conducted in accordance with procedures found in NPS-18. Each review will be documented and filed with the final fire documentation. The Fire Management Officer will retain a file copy.

B. Annual Fire Summary Report

The Fire Management Officer will be responsible for completing an annual fire summary report. The report will contain the number of fires by type, acres burned by fuel type, cost summary, personnel utilized, hours of aircraft used, and fire effects.

C. Annual Fire Management Plan Review

The Fire Management Plan will be reviewed annually by the Fire Management Officer. Necessary updates or changes will be accomplished prior to the next fire season. Any additions, deletions, or changes will be reviewed by the Chief Ranger to determine if such alterations warrant revalidation of the plan by the Superintendent and Regional Director.

XVII. CONSULTATION AND COORDINATION

The Fire Management Officer and the Fire and Emergency Operations Specialist are responsible for coordination and consultation with cooperators regarding fire management activities. This includes involvement with the Northern Region Coordination Group, the Northern Region Training Committee, the Greater Yellowstone Area Fire Management Officers Committee, the Eastside Incident Management Team Committee, and the West Yellowstone Interagency Fire Center, and all local cooperators that include the Fire Management Officers of the GYA.

Further coordination with cooperators is described through various agreements found in Appendix F (Cooperative Agreements).

XVIII. APPENDICES (Following Plan)

APPENDIX A.	References Cited
APPENDIX B.	Glossary
APPENDIX C.	Summary of Park Fires
APPENDIX D.	Annual Fire Prevention Action Plan
APPENDIX E.	Cooperative Agreement / Memorandums of Understanding
APPENDIX F.	GYA Planning and Coordination Guide
APPENDIX G.	GYA Preparedness Plan

FORMS (Following Appendices)

APPENDIX H.	Yellowstone Fire Management Committee Report
APPENDIX I.	Yellowstone Monitoring Guide
APPENDIX J.	Fire Situation Analysis
APPENDIX K.	Escaped Fire Situation Analysis
APPENDIX L.	Prescribed Burn Plan
APPENDIX M.	Delegation of Authority
APPENDIX N.	Large Fire Briefing
APPENDIX O.	Fire Complexity
APPENDIX P.	Guideline for Park Closures

DETACHED APPENDICES

APPENDIX Q.	Aviation Management Plan
APPENDIX R.	Hazard Fuels Management Plan
APPENDIX S.	Prescribed Fire Monitoring Handbook
APPENDIX T.	Environmental Compliance