Fire Management Plan

an addendum to the Natural Resources Management Plan

including: Environmental Assessment
Finding of No Significant Impact

Golden Gate
National Recreation Area

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FIRE MANAGEMENT PLAN

GOLDEN GATE NATIONAL RECREATION AREA

1993

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ABSTRACT

This update of the Fire Management Plan is an addendum to the Natural Resources Management Plan (1990a). The fire management policy of the National Park Service (NPS-18, 1990b) recognizes the natural or unnatural occurrence or absence of fire as an integral factor influencing all ecosystems. Within the text of this document is an interpretation of national policy at the local level, specifically Golden Gate National Recreation Area. Interested parties must review these contents in relation to the enabling legislation which created the Recreation Area. The legislation dictates that the acreage be set aside in order to preserve for public use and enjoyment certain areas of San Francisco, Marin and San Mateo Counties. The legislation dictates utilization of the resources in a manner which provides for recreation and educational opportunities and is consistent with sound principles of land use planning. In conclusion it calls for preservation of the natural character of the land and protection from uses that would destroy that natural character.

This fire management plan has been written in a fashion that will provide for a solid foundation and justification of a complete fire management program, addressing both fire suppression and the use of prescription fire. This document is intended to be an action plan. The thrust of the plan is to document fire effects; the ecological role of fire in each plant community; and the historical fire regimes of the area; provide recommendations for management, and to outline a schedule and method for the implementation of recommendations.

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I. INTRODUCTION

The National Park Service has recognized fire as a natural process which has a role in many ecological communities (NPS Management Policies 1978). Many national parks are reintroducing fire to maintain the ecology of plant and animal communities and reduce fire hazard. Fire is a significant factor in Mediterranean ecosystems; such as those found in California. Many plants are adapted to fire, and tree growth rings document significant fire histories. Mediterranean plant communities change in the absence of fire and fuels build up to hazardous proportions.

The lands of Golden Gate National Recreation Area have had a policy of fire suppression for over 100 years. Hazardous fuel build-ups are occurring in several plant communities including native chaparral and introduced eucalyptus which are highly flammable.

Using fire as a management tool can reduce fire hazards and help restore native ecosystems. This fire management plan emphasizes a program using prescribed fire and fire suppression. All unplanned fires will be treated in a suppression mode.

The authority for fire management in Golden Gate National Recreation Area is found in the National Park Service Organic Act (NPS 1916), which states the agency's purpose:

> "...to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

This authority is further clarified in the National Parks and Recreation Act of 1978:

> "Congress declares that ...these areas, though distinct in character, are united ...into one national park system... The authorization of activities shall be construed and the protection, management, and administration of these areas shall be conducted in light of the high public value and integrity of the National Park System and shall not be exercised in derogation of the values and purposes for which these various areas have been established except as may have been or shall be directly and specifically provided by Congress."

The Golden Gate National Recreation Area Fire Management Plan is an addendum to the Natural Resources Management Plan (1982, 1990a). The general management objectives of the fire management plan are to:

- Protect human life, property, and cultural and natural resources.
- Provide a policy statement on wildland and management fires in the park.

- Guide management actions on wildland and management fires that are most cost effective and will have the least amount of impact on the natural resources.

- Provide for the implementation of a fire management program which will reduce fuel loadings.

- Restore fire as a natural component of the ecosystem.

- Identify information needed to refine prescriptions and better understand fire behavior and effects.

- Establish an organization of properly trained personnel capable of carrying out a professional fire management program.

The specific objectives of this plan are to:

- Define the goals of the fire management program.

- Review the role that fire plays in the different communities.

- Describe fire management units.

- Integrate fire as a natural process into communities to the fullest extent possible.

- Enhance the habitat of sensitive species.

- Influence natural successional patterns.

- Restore or maintain an historic scene.

- Control the invasion of exotic species.

- Define prescriptions for fire management units.

- Assign fire management responsibilities, and outline procedures for handling wildland and prescribed fires.

The prescribed fire program consists of prescribed burns conducted to better understand the role of fire at Golden Gate National Recreation Area. Revisions of this plan will be needed periodically as more burn data is compiled and fuel loadings are reduced.

This document emphasizes the large open lands within Golden Gate National Recreation Area which are located in Marin and San Mateo Counties. The Fire Management Units are defined by the major vegetative communities found throughout the Recreation Area. A literature review on the effects

of fire within these communities is provided within the text of this plan in order to direct management in meeting specific objectives.

II. DESCRIPTION OF AREA

Detailed descriptions of Golden Gate National Recreation Area can be found in the Preliminary Information Base (SWA 1975), the General Management Plan (NPS 1980) and the Natural Resources Management Plan (NPS 1982; 1990a). These descriptions are general in nature and do not provide the information for implementation of a fire management program. Golden Gate National Recreation Area is located along the northern California coast of Marin, San Francisco and San Mateo Counties. The park is divided into two areas separated by the Golden Gate Bridge (Figure 1). The northern area is in Marin County and is part of a large greenbelt which includes Point Reyes National Seashore, Mount Tamalpais State Park, Marin Municipal Water District and several private holdings. The southern area is in San Francisco and San Mateo Counties and is part of a large greenbelt including the San Francisco Watershed and several San Mateo County Parks.

San Francisco Area Description

The San Francisco area consists of mostly landscaped areas. Much of the natural features have been altered by development. The San Francisco area will remain in suppression mode due to the proximity of the urban interface. The San Francisco and Presidio Fire Departments respond to all fire in the area, although there is currently no formal agreement with San Francisco. The Presidio is a recent acquisition within the San Francisco area. Preliminary assessment and planning for the area is currently underway. An addendum to this plan will be written concerning the Presidio once a data base is formulated. The native plant communities in the San Francisco Unit include: (1) Grassland and Coastal Scrub, (2) Coastal Sand Dunes, (3) Coastal Strand, (4) Streambank, and (5) Rock Outcrops.

Marin Area Description

The geology of the Marin area of Golden Gate National Recreation Area is a complex assortment of igneous, metamorphic and sedimentary rocks. The bedrock is the Franciscan Assemblage which includes sandstone, shale, chert, greenstone (sub-marine basalt lava) and metamorphic rock (Wahrhaftig 1974).

The soil consists mainly of residual bedrock material. Small areas of soils developed on alluvial valleys, coastal plain deposits, dunelands and marshlands are found throughout the park (SWA Group 1975). The soils range from shallow, rocky and unproductive, to deep, developed forest soils that house healthy stands of coastal redwood (*Sequoia sempervirens*) and Douglas fir (*Pseudotsuga menziesii*).

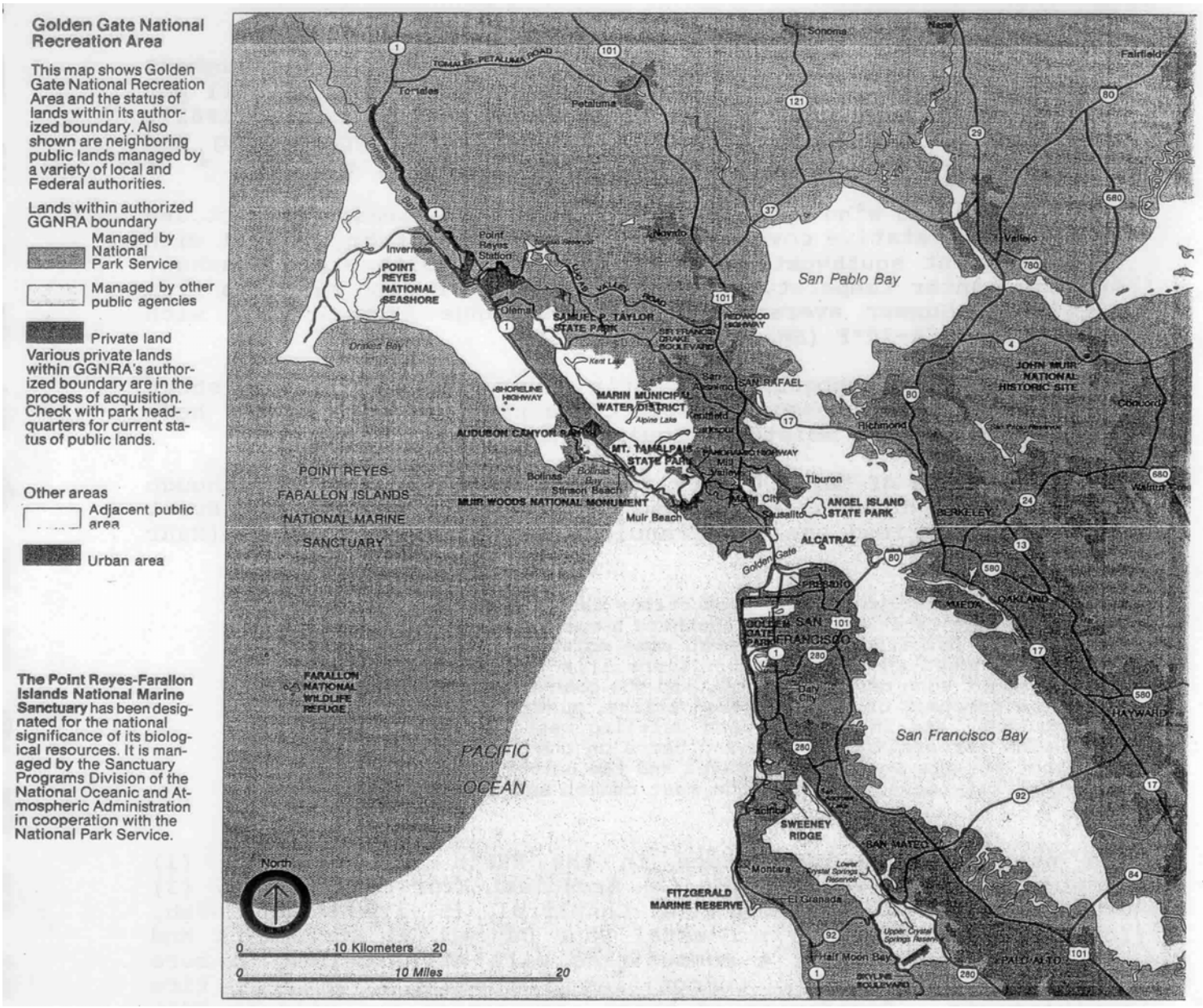

Figure 1. Golden Gate National Recreation Area: location of Marin, San Francisco and San Mateo Areas.

Six water drainages flow through these lands. Southernmost is Rodeo Lagoon and moving northward are Tennessee Creek, Redwood Creek, Pine Gulch Creek, Olema Creek and Lagunitas Creek. Smaller drainages, stock ponds, lagoons and springs are also included in the water resource.

The highest amount of runoff is during the months of highest rainfall, November to April. The average amount of rainfall per year varies with location from 20 inches to 48 inches (NPS 1982). Fog drip is an important water source during late spring and summer often adding an additional 10-20 inches of moisture.

Temperature and wind speed vary with elevation, season, aspect and amount of vegetative cover. Winds are generally from the west with less frequent southwesterly winds associated with storm passage. Average winter temperatures range from 48-53°F with minimums from 45-50°F. Summer average temperatures range from 55-65°F with maximums of 64-70°F (SWA 1975).

The climate and topography of Marin County can change over short distances. Plant communities in close proximity can easily have different soil and moisture requirements (Howell 1970).

Early accounts of Marin County are rare (Mayfield 1978), although some accounts do exist. Chamisso, the naturalist aboard the Rurik in 1816, described the San Francisco Bay Area as follows (Mahr 1932):

> "much poorer in natural productions than the coast of [Chile] under the same latitude [of the southern hemisphere]. In the spring, when winter has afforded the earth some moisture, the hills and valleys are indeed adorned with brilliant iris and other flowers but the drought soon destroys them ...and the country exhibits in autumn only the prospect of bare scorched tracts, alternating with poor stunted bushes, and in places, with dazzling wastes of draft sand. Dark pine forests appear here and there on the ridges of the mountains, between the Punta de los Reyes and the harbor of San Francisco. The prickly-leaved oak... is the most common and largest tree."

The native plant communities in the Marin Unit include: (1) Redwood/Douglas Fir Forests, (2) Broadleaf Evergreen Forest, (3) Grassland and Coastal Scrub, (4) Chaparral, (5) Freshwater Marsh, (6) Saltwater Marsh, (7) Coastal Sand Dunes, (8) Streambank and Lakeshore. The first 4 communities will be described in more detail in this text. Communities 5 through 8 are not fire environments. Boundaries of these communities are used to help define fire management units and are further described by Howell (1970).

Sweeney and Milagra Ridge Area Description

Sweeney Ridge has a bedrock of the Franciscan Assemblage previously described. The surface soils on the site are primarily Montara-Climara and Sweeney-Mindego associations; a small western section contains Tunita-Lockwood association soils. The first two associations are generally shallow, have clay to clay-loam textures and are somewhat excessively drained and are highly erodible. The Tunita-Lockwood soils are deep with good drainage and low erosion hazard potential (HKS Associates 1980).

Mean annual rainfall is about 30 inches and usually occurs between November and April. Five separate watersheds are in the area: Linda Mar; Vallemar; San Andreas; San Francisco Jail; and Fairway Park watersheds.

Early descriptions of the coastal terraces and hills of San Mateo County frequently mentioned grass-covered hills and burnt grasslands, with heavily wooded arroyos, and little mention of the large expanse of scrub as seen today (Clarke 1952; Mayfield 1978). The major native vegetation communities are: (1) Coastal Scrub and Grassland, (2) Riparian, (3) Wetlands, and (4) Rock Outcrops. The first community will be described in more detail in this text. Communities 2 through 4 are not fire environments. Boundaries of these communities are used to help define fire management units and are further described by Thomas (1961).

Fire Environment

The history of fire in the central coast region can be divided up roughly into five eras (Langenheim et al. 1983), each with a distinct fire regime: pre-human (up to 9-10,000 years B.P.); Native American (9-10,000 B.P. to 1792 A.D.); Spanish-Mexican (1792 to 1848); early Anglo (1848 to 1929); and recent (1929 to present). Although lightning fires continue to occur, the natural fire regime ended with the arrival of the Miwok and the Ohlone.

Natural Fire Occurrence

The fire history of Golden Gate National Recreation Area suggests that probable burning regimes in pre-historic times resulted from lightning-ignited fires, spontaneous combustion and Native American-ignited fires. The following discussion involves the probable historic fire regimes through examination of three characteristics of the area: climate; plant ecology; and Native American history.

Golden Gate National Recreation Area is in the coast region and has a Mediterranean climate. Four important characteristics make up this type of climate: (1) warm to hot summers and mild winters, (2) a moderate marine air influence throughout the year, (3) a concentration of the year's moderate amount of precipitation in

winter; and summers that are nearly or completely dry, and (4) extended periods of sunny weather with few clouds, especially in summer (Morris 1977). These features create a climate in which high fire danger often exists. High fire danger months are from May through November.

Sunget and Martin (1984) studied the occurrence of lightning in the Marin coastal area. Storms with lightning occurred 1.8 times/year at Point Reyes and 1.9 times/year at Mount Tamalpais in the years 1901, 1908-1926. Weather stations at these two points indicate that 18% of these storms occurred in September. At this time fuels are dry; relative humidities are low; temperatures are high; and winds are frequently of high velocity.

Several lightning ignitions are known to have occurred in the last 18 years. Local fire sources (Jennings 1984; Sunget & Martin 1984) tell of thirteen separate lightning-ignited fires: two in the Douglas fir forest on Inverness Ridge, two on Mount Tamalpais, one behind Stinson Beach, and eight additional fires (seven of which occurred during a September 1984 storm). This data suggests fires occur along the Marin coastline regardless of the high probability of dense fog throughout much of the year.

A fire chronology based on fire scar examination was done for two redwood (*Sequoia sempervirens*) forest sites in Marin County (McBride & Jacobs 1978). Fire frequencies averaged 21.7 and 27.3 years. The difference between the two sites was attributed to fog gradient (Jacobs et al. 1985). The moister site was less flammable and therefore fire occurred less often. The distribution of fire intervals was skewed and displayed more short than long intervals between fires. This suggests that fires were separated by first a short and then a longer time interval. Such information is important in timing prescribed fire intervals.

A fire chronology of the Bear Valley area at Point Reyes National Seashore was done on two Douglas fir (*Pseudotsuga menziesii*) trees (Sunget & Martin 1984). The average fire return interval for one tree was 10 years during the period from 1777 to 1858. The other tree had an average fire return interval of 13 years during the period from 1771 to 1860. These intervals are shorter than expected and are probably related to the fact that Bear Valley was a center for much Native American activity and associated burning practices.

Vegetation characteristics in regions of Mediterranean climate help determine the frequency and intensity of fires (Philpot 1977). Plants are adapted to fire and in some cases encourage fire with their very nature (Mutch 1970). Several communities, including native chaparral and oak woodland in Marin and San Mateo display these fire adaptive characteristics. These communities are somewhat dependent on fire suggesting that their presence today evolved due to historical fire occurrence.

Plant traits of many species in Marin and San Mateo show adaptations to fire. The four major adaptive traits to fire are:(1) bud protection and sprouting; (2) fire-induced flowering; (3)on plant seed storage; and (4)

fire stimulated germination (Gill 1977). Specific plants which display these adaptations are discussed under Fire Management Unit descriptions.

Native American Influences

In California, the oldest definite evidence indicates that humans arrived from 9,000-10,000 years ago (Heizer & Elsasser 1980) and many tribes in California burned the landscape (Stewart 1955). At least 35 tribes in central and northern California used fire to increase the yield of desired seeds (Reynolds 1959). Thirty-three tribes drove game with fire and 22 tribes used fire to stimulate the growth of tobacco. Fire was also used as a tool to make vegetable food available, facilitate the collection of seeds, improve visibility and for protection from snakes. The available evidence indicates that Native Americans generally burned in the fall season (Lewis 1974). Fall burns are frequently noted in grasslands, chaparral and coniferous forests.

Ohlone and Miwok cultures occupied the lands of Golden Gate National Recreation Area. The Ohlone burned extensive areas each fall to promote growth of seed bearing annuals, increase available grazing areas and facilitate the gathering of acorns (Levy 1978a). Although information on the coastal Miwok burning practices are scant, it is known that inland Miwok burned the land each August after seed gathering from May to August (Levy 1978b). The Bear Valley fire chronology (Sunget & Martin 1984) suggests that the coastal Miwok burned the land more frequently than lightning ignited fires occurred.

This evidence suggests that fire occurred historically in the lands of Golden Gate National Recreation Area. This plan does not distinguish between the roles of Native American and lightning fires. It recognizes that Native American burning occurred more often than lightning fires. The intention is not to duplicate Native American burning but to recognize that it influenced fire frequency and the vegetative mosaic.

Spanish-Mexican Influences

Although there is little documentation of Spanish and Mexican burning practices, the arrival of Portola heralded a new era in 1769. Many Native Americans were incarcerated in missions, virtually causing the extinction of the native population and the Native American way of life. The government enacted regulations against burning to protect the standing hay crop for their cattle (Gordon 1977).

Despite these regulations the Spanish rancheros burned coastal

scrub, chaparral and oak woodland to expand pastures. This was a major shift from the native burning of grasslands. This change was also accompanied by overgrazing, cultivation, the beginning of the extirpation of many native animal species (including the grizzly bear), and the beginning of accidental and purposeful introduction of exotic plant species.

Modern Influences

The late 1800's and early 1900's in central California were times when wildland fires were frequent and large (Perry 1984) (Table 1). In many cases this fire history maintained the grasslands from being invaded by brush. Fire was used by early settlers to clear land and improve grazing. Grazing was widely practiced and many areas were cleared for pasture land. This behavior resulted in lighter fuel loading, especially near residential areas, markedly lowering the fire danger for the area. Many of these burning and grazing practices lasted until the 1960's.

Following the 1960's a marked drop in area-wide burning has taken place.

In general, disturbances by fire have gone from long intervals in the pre-human era to shorter intervals in the Native American, Spanish-Mexican, and early Anglo eras, back to long intervals in the modern era. The vegetation patterns exhibited today have been largely influenced by these changes.

Table 1. FIRE HISTORY OF COASTAL MARIN AND SAN MATEO COUNTIES

Nineteenth and early 20th century newspapers from Marin and San Mateo Counties and records from local fire departments document many fires which occurred in coastal Marin and San Mateo Counties (Perry 1984; U.S. Forest Service 1939-41). These fires were often the result of known human activities, but the locations and impacts of these fires are often vague. Months are given when known.

1859	September	Wildland fire, Mt. Tamalpais, burned for three months.
1865		The woods of Marin along the shore of Bolinas Bay burned for two weeks.
1877		Area west of San Andreas Lake burned over large territory for more than three weeks.
1878		1,200-1,500 acres of chaparral, grass and timber burned near Nicasio.
1881	September	65,000 acre wildland fire, burned for seven days, one fatality. Started near Blithedale Canyon, Mill Valley, by a man who set fire to a pile of brush.
1887		Fire spread from below San Andreas Lake to San Mateo Creek burning 2,500 acres of second growth bay, oak and madrone.
1889		On the ridge between San Andreas Lake and Crystal Springs Lake and two ridges west of San Andreas Lake: "for miles the hills are black and bare, the fire burned for at least 4 days spreading at least 1h square miles a day."
1890	October	More than 8,000 acres burned between San Rafael and Bolinas.
1891	June	12,000 acres of Mt. Tamalpais burned; the fire started in Bill Williams Gulch near Ross.
1892	August	Fire started on Bolinas Road by two men cooking breakfast, spread over several hundred acres.
1893	August	Fire thought to have been started by campers burned over 3,000 acres of Mt. Tamalpais and Mill Valley.
1894	September	Mill Valley fire originated from a campfire left by hunters started in redwood forest and "burned over a large stretch of country".
1904	September	15,000-20,000 acres of grass and timber burned on the west side of Bolinas Ridge.
1913	July	Mt.Tamalpais, between 1600 and 2000 acres burned, from Rock Springs to Larkspur, including summit of mountain, Blithedale and Cascade Canyons, most of Fern Canyon, and spot fires beyond Muir Woods on the Dipsea Trail. Started 1/4 mile west of West Point Inn at 10 a.m., probably by railroad sparks.

Table 1. (cont.)

FIRE HISTORY OF COASTAL MARIN AND SAN MATEO COUNTIES

1919	September	Fire started near Pipeline Reservoir, burned 40 houses on the ridge and stopped within 100 yards of Muir Woods.
1919		Fire swept from the hills above Sausalito, burned a hall, 5 stores and 12 homes.
1923		A fire burned from Bolinas Ridge to within 4 miles of Fairfax, with a total size of 30-50 square miles.
1928		200 acres of brush burned around Fort Barry.
1929	July	"Great Mt. Tamalpais Fire", 2500 acres of brush, forest and grassland. Fire burned into Mill Valley from Fern and Cascade Canyons, 117 homes burned.
1929		A week long fire around the town of Montara, completely burned down the town.
1931	December	Illegal campfire in large group of charred redwoods in Cathedral Grove, Muir Woods.
1932	November	Thanksgiving Eve Fire. Started at 10:25 p.m. in heavy grass 50 feet west of Panoramic Highway near Alpine Club. North winds spread it toward Muir Woods and Tourist Club, sixty acres burned, including 2 acres of chaparral inside Muir Woods boundaries.
1933	December	Fires prohibited in Muir Woods; all fireplaces eliminated.
1945	September	18,000 acre fire that began at the entrance to Carson Canyon (Kent Lake).
1959	July	2:53 a.m. fire report in Kent Canyon near logging operations on Brazil Ranch. No wind, but burned 50 acres before being controlled by 75 men.
1965	October	150 acre fire ~j mile from Muir Woods, near southeast boundary.

III. COMPLIANCE WITH NPS POLICY

This plan takes its direction from various sources. First, according to NPS Wildland Fire Management Guidelines (NPS-18 1990b):

> "Fire is a powerful phenomenon with the potential to drastically alter the vegetative cover of any park. Fire may contribute to or hinder the achievement of park objectives. Park fire management programs will be designed around resource management objectives and the various management zones of the park. Fire related management objectives will be clearly stated in a fire management plan, which is to be prepared for each park with vegetation capable of burning, to guide a fire management program that is responsive to park needs."

Golden Gate National Recreation Area was established by Public Law 92-589, H.R. 16444, October 27, 1972, which states:

> "In order to preserve for public use and enjoyment certain areas of Marin and San Francisco Counties, California (San Mateo County added by P.L. #96-607), possessing outstanding natural, historic, scenic, and recreational values, and in order to provide for the maintenance of needed recreational open space necessary to urban environment and planning, the Golden Gate National Recreation Area... is hereby established. In the management of the Recreation Area, the Secretary of Interior... shall preserve the Recreation Area, as far as possible, in its natural setting, and protect it from development and uses which would destroy the scenic beauty and natural character of the area."

The fire management plan is mandated within by the Golden Gate National Recreation Area General Management Plan (1980) and is considered to be an addendum to the Natural Resources Management Plan (1982 & 1990a). The General Management Plan states:

> "The GGNRA land in Marin County south of Olema Valley will be managed to preserve a diversity of settings. The mosaic coastal scrub and prairie will be maintained. To achieve this may require a prescribed program of mowing, grazing, and burning. It is particularly important that grasslands be maintained or even expanded near facilities in the Marin Headlands and along access roads to encourage casual uses of open space."

> "Muir Woods will be managed to protect and interpret the large redwood trees. To do this will require continued intervention in the normal ecological succession of the forest. This may involve, for example, the planting of new trees and the selective thinning of old stands, or even prescribed burning."

The Natural Resources Management Plan states:

> "Many plants in the fire adapted communities here, such as chaparral and oak woodland are dependent on fire effects and the condition of the communities is in decline. Both chaparral and oak woodland communities are succeeding to forests and species are being lost. Many of the rare species of GGNRA exist in the remnant chaparral community. The biological diversity of the park is threatened due

to the absence of fire.”

“The fire management program is designed to provide quantitative information about the effects of fire in several ecosystems of the Marin Unit. Research will be conducted to determine the short and long term effects of fire on plant and community composition.”

IV. PARK FIRE MANAGEMENT POLICY

The paramount considerations of this park fire management program will be:

- The protection of human life
- The protection of facilities and cultural resources
- The perpetuation of natural resources and their associated processes

Management fires, or prescribed fires are those fires which contribute to the attainment of the management objectives of a park through the execution of predetermined prescriptions defined in detail in the Fire Management Plan.

In ecosystems modified by prolonged exclusion of fire, prescribed burning may be used to restore fuel loading or vegetative composition to natural levels, or to create narrow fuel breaks along boundaries of a fire management area and thereby reduce the probability of wildfires crossing into or out of that area.

Golden Gate National Recreation Area Fire Management Objectives:

- Protect human life and property both within and adjacent to park areas
- Protect natural and cultural resources and the intrinsic values from unacceptable impacts attributable to fire and fire management activities
- Perpetuate, restore, replace or replicate natural processes when and where appropriate
- Manage all forms of wildland fire (wildfire and prescribed fire) to achieve identified management goals
- Promote an interagency approach to managing fires on an ecosystem basis
- Employ strategies which minimize costs and resource damage, consistent with values at risk, to suppress all wildfires
- Prevent unplanned human-caused ignitions
- Restore and rehabilitate facilities lost in or damaged by fire or suppression activities

- Promote public understanding of fire management programs and objectives
- Conduct fire management programs in a manner consistent with applicable laws, policies and regulations
- Organize and maintain a fire management capability which consistently applies the highest standards of professional and technical expertise
- Encourage research to advance the understanding of fire behavior, effects, ecology, and management
- Integrate fire management with all other aspects of park management
- Manage all wildfires using the Incident Command System
- Suppress all wildfires
- Conduct management fires in accordance with this plan

V. FIRE MANAGEMENT STRATEGIES

The objective of the fire management program is to develop an integrated program where management fires are used to perpetuate fire dependent-natural systems and wildfires are suppressed in a manner that results in a minimum of damage to resources. Golden Gate National Recreation Area has a large urban interface as well as interfacing with other land management agencies. Fire management activities must be developed in cooperation with adjacent government agencies and must be designed to avoid economic losses to adjacent landowners. Therefore, Golden Gate National Recreation Area has adopted a program that utilizes prescribed fire, mechanical manipulation of hazard fuels and suppression of all wildfires.

Fire suppression will be accomplished through a combination of cooperative agreements with local fire agencies and maintaining qualified park fire personnel. Annual operating plans will identify individual suppression concerns in order to minimize suppression impacts. Interagency training will be conducted to develop a working relationship with local agencies.

Unlike some Sierran parks, where natural fires are allowed to burn under prescribed conditions, local vegetation is continuous over adjacent public and private lands. Thus, the long-term management of fire at Golden Gate National Recreation Area requires the use of prescribed fire to mimic the effects of natural fires. This, in turn, requires a comprehensive understanding of the natural succession of vegetation in the park and the role of fire as an important element in this natural process.

Prescribed fires will be conducted with qualified park personnel and assistance of local fire agencies.

The Recreation Area has been divided into six Fire Management Units, identified primarily on the basis of the dominant plant communities.

A five year plan is proposed using a combination of prescribed burning, mechanical manipulation of fuels, fire suppression, and fire effects monitoring.

During the next five years prescribed burns will be conducted in coastal prairies, coastal scrub, oak woodlands, and redwood forest. Prescribed burns will also be used to lower the fuel hazard in the eucalyptus understory and will be used to determine fire's effect on exotic plants as well as fire's contributing effect in the restoration of natural plant communities.

Park-Wide Constraints on the Fire Management Strategy Options

All wildfires are suppressed. Suppression of all wildfires does

not allow for natural fire occurrence and therefore none of the benefits of natural fire are achieved.

Bulldozers will not be used accept with the approval of the Superintendent or representative.

Fugative retardant will be used and requested whenever air drops are necessary during the suppression of wildfires.

Air quality issues are a priority in both wildland suppression and prescribed fires.

The location of park property and its relationship to developed areas directs the fire management planning for both suppression and management fires.

Each year special protection areas will be identified and each cooperator's annual operating plan will include location and protection requirements

VI. FIRE MANAGEMENT UNITS (FMUS)

Fire management in Golden Gate National Recreation Area consists of suppression actions supplemented by the use of mechanical manipulation and prescribed fire. All unplanned ignitions are suppressed, although they may be allowed to burn themselves out within nearby natural or man-made barriers such as dunes, cliffs, roads or lakes. Suppression tactics will be chosen that have the least impact to natural resources. The Fire Management Units will be used for prescribed fire application.

Prescribed fire will be used within Fire Management Units defined by the six plant communities found within Golden Gate National Recreation Area: (1) Grassland and Coastal Scrub, (2) Broadleaf Evergreen Forest, (3) Chaparral, (4) Old Growth Redwood, (5) Second Growth Redwood and Douglas Fir, (6) Eucalyptus/Other Exotics.

Cultural resources and threatened and endangered species are dealt with in this plan under the environmental assessment and special concerns for each Fire Management Unit.

A. GRASSLAND AND COASTAL SCRUB

The grassland community at Golden Gate National Recreation Area extends from sea level to nearly 2600 feet. It forms a mosaic with the coastal scrub community and mixed evergreen forests (Savage 1974). Annual rainfall is between 25 and 75 inches with fog and wind occurring frequently. Summer maximum temperatures average 63-75°F and mean winter minimum temperatures average 35-40°F (Munz & Keck 1968).

Prescribed fires have been initiated and an active fire management program is currently taking place. When the objective is to reduce exotic plant densities while encouraging native perennials, it is advantageous to burn in fall or early winter (Bartolome 1984). Germination of annual grasses and forbs often occurs one to three weeks after the first rain (Bartolome 1979). Burning during this period could destroy the annual seed crop thereby reducing competition of annuals. The perennial rootstock is wet after the first rain and less susceptible to fire intensities (Biswell per. com. 1984).

General Ecology

It is generally accepted that lightning fires are part of the evolutionary forces affecting grassland (Heady 1972). Native American burning has occurred for the last 8,000 years or more; early narrative reports mention Native American burning, many of which burned larger areas than intended (Sampson 1944b). The coastal prairie appears to have evolved under light seasonal grazing pressure with occasional fire (Heady et al. 1977). Fire

was apparently necessary for soil nutrient renewal (Mutch 1970).

Pristine grassland was thought to have been composed of evenly spaced bunchgrasses with annual forbs occupying areas between tussocks. It has been shown that *Stipa pulchra* was a major dominant of that grassland type (Bartolome et al 1986). The lack of continuous fuels and compactness of bunches themselves would have resulted in fires of moderate intensity with low to moderate rates of spread.

The grasslands have had the greatest disturbance of any natural habitat in Marin County (Savage 1974). Four main factors have contributed to this disturbance (Heady et al. 1977): (1) an increase in grazing pressures (2) the introduction of highly competitive exotics (3) cultivation and (4) the elimination of fire. Pristine coastal prairie was composed of perennial grasses where today Mediterranean annuals dominate.

The result of this grassland disturbance has been the replacement of evenly-spaced perennial grasses with dense stands of annual grasses. The dense stands burn with greater intensity and more rapid rates of spread. Additionally, annual species cure rapidly with the onset of summer drought, resulting in a longer fire season (Langenheim et al. 1983).

Tilling and controlled grazing or clipping experiments have been employed in an attempt to enhance native perennial grasses in rangelands (Heady 1956). Dennis (1989) found that the timing of grazing is critical, and concluded that annual vegetation affects the growth of perennials more through its influence on the physical environment than through resource competition.

Exclusion of grazing, extirpation of large mammals and suppression of wildfires have caused a marked increase in acreage covered by coyote bush (*Baccharis pilularis*) and the resulting coastal scrub community in the Bay Area (McBride & Heady 1968; Clark 1952). It should be noted that grassland and coastal scrub communities are a dynamic mosaic with changes in dominance over time (Russell 1983); and in some areas these two communities are in equilibrium with no invasion occurring (Davidson & Barbour 1977). The boundary between grassland and coastal scrub is probably maintained by one or more of the following factors: allelopathy, herbivory, limited seed dispersal and differential use of soil moisture (Davis and Mooney, 1985). Invasions of coyote brush are sporadic with the shrub canopy developing quickly, effectively shading out most grassland species and providing shelter for herbivores which further reduce grassland species (Hobbs and Mooney 1986).

Fire Ecology

Little research has been done on the effects of fire with respect to California annual grassland. Generally, fires remove dry

vegetation and mulch which encourages a shift towards forbs such as filarees and clovers that do well with little mulch. Grass cover can be reduced by 45% on burned sites (Hervey 1949).

At least one native perennial grass, purple needle grass (*Stipa pulchra*), appears to have evolved under periodic fire (Bartolome 1981). Purple needle grass thrives when annual grassland is burned or grazing occurs in the fall season (Bartolome & Gemmill 1981). Disturbance during other seasons is detrimental to the plant. This data suggests that the plant has adapted to fire which is frequent in the fall, rather than grazing which is common in any season. Purple needle grass can be favored by burning in the fall to decrease competition and provide a suitable seedbed (Bartolome 1981).

Studies at Jepson Prairie in Solano County investigating different management techniques used to enhance native prairie found that the ideal management strategy was: controlled grazing in late March to early April followed by a late summer prescribed burn on a three-year cycle (Menke per. com. 1991).

Daubenmire (1968) found that many perennial grasses are conspicuously stimulated by fire with enhanced flowering activity which can persist for 2-12 years. He further concluded that though the cause of this enhanced growth was obscure, it seemed to be associated with the removal of litter by fire. McClaran (1981) observed that burning or tilling after germination eliminates the new seedling population of alien plants and thus reduces the alien plant seed bank. Parsons and Stohlgren (1989) found that burning did not have a long term effect on annual grasses and concluded that prescribed burning may have to be part of a permanent management program.

Prescribed burning research at Henry Coe State Park supports the hypothesis that the presence of heavy annual mulch residue is an inhibitor to perennial grass (Parker 1989). Fall burning was found to reduce the abundance of annual grasses while increasing the diversity of native species. This research also concluded that reduction in annual grass mulch will potentially increase perennial grass establishment. Parker recommended the planting of islands of grassland species as well as the sowing of seeds of grasslands species in burned areas.

Ahmed (1983) found that the timing of the burn had little effect on the overall growth of *Stipa pulchra*; density was not affected by the burn treatments although associated annuals were greatly reduced. In addition the *Stipa* seed bank, seed viability, and seedling survival were all higher under burn treatments.

Seeding and/or transplanting using *Stipa pulchra* and other grassland species post burn may be successful (Parker 1989). *Stipa* can survive low intensity fire at two years of age. The second

burn could occur later in the season to further reduce annual and competition (Dennis 1983).

Fire can also be used to slow the invasion of coyote bush *(Baccharis pilularis)* into annual grassland (McBride & Heady 1968; McBride 1974). The reintroduction of fire to duplicate natural processes will kill susceptible seedlings and top kill some adult plants. Ford (1991) has found that the rate of cover regrowth is inversely related to fire severity.

Grazing is being removed from some grasslands at Golden Gate National Recreation Area. This will ultimately create a fuel buildup (Biswell 1974), but may help to restore native species. Fuel loadings can be kept to an acceptable level through burning while possibly increasing the nutritional quality of the grasses for native wildlife.

Summary and Conclusions

Pristine coastal grassland was composed of native perennial grasses and was not threatened by exotic plant invasion as it is today. Evidence suggests that at least some native perennial grasses are adapted to fall burning.

The prescribed fire program in the grassland/coastal scrub community consists of small prescribed burns (1-35 acres). The objective of these burns is to monitor the fire behavior and effects to verify the perpetuation of native species, reduce invading species and reduce fuel when appropriate. Prescriptions for each objective are continually being refined.

B. BROADLEAF EVERGREEN FOREST

This variable community extends from 200 to 2500 feet in elevation (Munz & Keck 1968), and is dominated by oak *(Quercus spp.),* California bay *(Umbe11ularia californica)* and/or tanbark oak *(Lithocarpus densiflorus).* Along the mesic boundary of this mixed evergreen forest is the redwood/Douglas fir community and along the xeric boundary is the coastal scrub and grasslands (Sawyer et al. 1977). Rainfall averages 25-65 inches a year with some fog. Mean summer temperature extremes range from 75-95°F and mean winter extremes from 29-39°F (Munz & Keck 1968).

Prescribed research fires in this community will be initiated with the following objectives:

- To research fire behavior and effects on mixed broadleaf community species
- To refine prescriptions

- To return the natural process of fire into the community

Isolated pockets of heavy fuel accumulation can be expected to create erratic but localized fire behavior. Initial treatment of these stands will be designed to keep fire intensity at a minimum.

General Ecology

Coastal live oak (Q*uercus agrifolia*) dominates this community at elevations below 1000 feet. It is often the only species present on hills frequented by a cool foggy coastal climate. Interior live oak (*Quercus wislizenii*) sometimes replaces coastal live oak in canyon bottoms and north-facing slopes. As the community approaches 1000 feet in elevation, California bay (*Umbellularia californica*) and other hardwoods become common.

Fire Ecology

The old-growth oak woodlands are stately California communities that deserve preservation. Little doubt exists as to the past occurrence of fire in this community and the subsequent sprouting of young oak (Plumb 1980). As for mature oak, bark thickness is the most important factor contributing to its degree of fire tolerance. Coastal live oak has thick bark and is therefore the most resistant to fire. It sprouts from the main trunk and upper branches following complete charring (Plumb & McDonald 1981).

Prescribed burns in Cuyumaca State Park have shown that coast live oak and canyon live oak (Q*uercus chrysolepis*) respond well to a low intensity, backing fire (Long per. com. 1984; Biswell per. com. 1984). Bark thickness, amount of dead bark, and sprouting ability from the bole all affect the growth of an oak species exposed to frequent fires (Plumb & McDonald 1981). Long (per. com. 1984) believes most oak species are receptive to light burns but recommends not burning while the trees are budding.

New oak sprouts which appear after fire are palatable and attractive to deer. Fire associated with increased browsing pressure can effectively kill oak (Biswell per. com. 1984).

Fall burns following rainfall will minimize erratic fire behavior and will most effectively reduce 10-100 hr. time lag fuels (Biswell per. com. 1984; Long per. com. 1984). Surface fine fuels (l hr.) will dry approximately one week after rain. Larger fuels dry throughout most of the summer. Thus, the reduction of 10-100 hr. time lag fuels can be accomplished under low fire intensities when duff layers are moist.

The coastal live oak communities support little ground fuel (probably less than 5 tons/acre) (Plumb 1980) and as a result associated fire intensities are minimal. The exception is where eucalypts are invading oak woodland. Here, this community has

become more susceptible to fire than it was historically.

Summary and Conclusions

The broadleaf evergreen forest has many fire resistant properties and many species sprout. Prescribed burns will determine fire effects on the community and help management to refine prescriptions. Management fires will then mimic the fire behavior and frequency traits which will best preserve the ecology of these species.

C. CHAPARRAL

Chaparral is not in abundance at Golden Gate National Recreation Area. Small communities exist in Muir Woods and the Marin Headlands, as well as a larger area on Bolinas Ridge. There are several types of chaparral in Golden Gate National Recreation Area:

Chamise Chaparral, dominated by chamise *(Adenostoma fasciculatum) is* characteristically found in hot, dry areas usually on south and west-facing slopes and ridges.

Ceanothus Chaparral is often dominated by a single species of ceanothus *(Ceanothus spp.)* and occurs on moister-sites than chamise chaparral.

Manzanita chaparral is dominated by species of manzanita *(Arctostaphylos spp.)* and usually occurs on deeper soils or on ridgelines and is generally not as extensive as the previous chaparral types.

Serpentine Chaparral is a low, open community associated with serpentine soils.

Mixed Chaparral is where the first three types intergrade.

Prescribed fire will be used within this community under the following objectives:

- To maintain species diversity
- To reduce the fire hazard by reducing fuel loadings
- To return the natural role of fire

Fire Ecology

Most species in the chaparral community are adapted to fire, sprouting being the most common adaptation. Species that do not sprout often have fire-resistant seeds that retain viability for

years. Almost all of the germination cues identified for these species are related to fire: heat; chemicals leached from charred wood; release from toxic compounds; increased light; and stratification (Parker and Kelly 1989).

Fire is often used to convert brushland, such as chaparral, to grassland. This can be accomplished through a series of successive burns in close proximity to each other, and may kill new brush seedlings before they produce seed (Emrick & Adams 1977). Additional amounts of forbs and grasses can strongly compete with resprouting chamise (James 1981). Vogl (1977) observed that coastal scrub communities can result from premature burning or increased fire frequency within chaparral.

Timing of prescribed burns and the resulting intensity can drastically influence post-fire development (Parker 1987; Florence 1987). Maintaining species diversity in chaparral is best accomplished by late summer or fall burns of medium intensities (Rundel 1982). Spring burns create more burl mortality in chamise (Stohlgren et al. 1984). The phenological state and depleted carbohydrate reserves are probably responsible for spring mortality associated with burning (Jones & Laude 1960). Carbohydrates are tied up in growing plant parts and deficiencies in root and lignotuber carbohydrates result in a lack of sprouting activity during this period. Fire can serve to: break down chaparral litter which is resistant to decomposition; remove inhibitors of decomposition; and alter the wettability of the soil.

Higher fire intensities are correlated with higher mortality in chamise (Stohlgren et al. 1984). Fires in mature chaparral are often very intense with flame lengths often exceeding 50 feet (Lotan et al. 1981). Temperatures can be as high as 1200°F (Sampson 1944b; Bentley & Fenner 1958) consuming all but the largest branches.

Indications are that organic and inorganic nutrient levels are increased as a result of fire (Christensen 1973; Christensen & Muller 1975). Soil levels of organic nitrogen are reduced , but the level of available nitrogen increases (Rundel 1981). Post-fire bacteria and fungi are more abundant in burned than unburned soils (Christensen 1973; Christensen & Muller 1975). Mineral levels as well as available nutrients added by ash increase dramatically (Hanes 1977).

"Fire in chaparral is both natural and inevitable" (Lotan et al. 1981). Chaparral foliage contain oils which enhance the flammability of the species. Most fuels are found in the aerial portion of the plant and are well aerated, continuous and have a high content of dead wood. Fire serves as the major cause of secondary succession by creating conditions necessary for seedling establishment (Craddock 1929), which allow chaparral ecosystems to perpetuate (Vogl 1982).

Rothermel and Philpot (1973) produced equations which predicted fuel loading and flammability over time in southern chaparral. The model shows live fuel building up quickly post burn. Dead fuel buildup is commonly associated with decadent stands. Recovery of chamise slows 6 years after burning (the annual growth rate declining until age 20-25) (Rundell & Parsons 1979). At 25 years chamise plants mature and begin to senesce. At 50 years, 500 of their canopy is dead fuel and thus significantly contributes to the fuel loading (Lotan et al. 1981).

The fire return interval for southern chaparral averages about 20 years. The mean fire interval for chaparral in central California is thought to be 45 years (Langenheim 1983). This average fire return interval coincides with the age of mature chamise. seeds in upper soil layers do not survive fire; therefore, prescribed fire intervals should be long enough to allow seed banks to build up (Parker & Kelly 1989).

The continued suppression of fires within this community has endangered many vegetative species that grow in association with it. California has 14 threatened species of Manzanita and an additional 11 that are considered endangered. Five species of Ceanothus are threatened and 4 others are endangered (Lotan et al. 1981). Golden Gate National Recreation Area has one endangered species of manzanita, two rare manzanita and one rare ceanothus.

The Natural Resource Management Plan (1990a) states: "The Mason's Ceanothus *(Ceanothus masonii) is* state listed and is a candidate for Federal listing. The only known population of this plant occurs at Bolinas Ridge in Marin County. Lack of fire in the habitat contributes to the decline of Mason's Ceanothus. Prescribed fire of moderate intensity may be necessary to stimulate gemination of this species and other species with hard seed coats (Parker per. com. 1991).

Coniferous species may be successional to chaparral. Intense fire may be needed to swing succession from hardwoods back to chaparral and can only be accomplished through a series of burns. Conifers and hardwoods both regenerate after moderate fire (Lotan et al. 1981) .

Summary and Conclusions

Chaparral is a fire adapted community that has been the subject of much study. The health of community diversity depends on fire. Without fire the community grows more flammable as more of the canopy becomes decadent. Prescribed fire will be used to reduce fuel loadings and to restore the natural role of fire to the community.

D. OLD-GROWTH REDWOOD

The majestic old-growth redwood forest at Muir Woods with Redwood Creek peacefully flowing through groves of tall trees is the object of much visitor attention. This tranquil scene is a rare site close to a large metropolitan area. Preservation of the pristine character of these woods is a management priority.

At Muir Woods, Redwood Creek canyon has a northwest-southeast alignment. Elevations range from 120 to 1320 feet. Average precipitation is 42 inches a year, average January temperature 57°F and average October temperature 61°F (McBride & Jacobs 1977).

Many species contribute to this ecosystem. Major over and understory trees include coastal redwood *(Sequoia sempervirens),* Douglas fir *(Pseudotsuga menziesii),* California bay laurel *(Umbellularia californica),* tanbark oak *(Lithocarpus densiflorus),* California hazel *(Corylus californica),* and madrone *(Arbutus menziesii).*

Prescribed fire will be used in Muir Woods in order to accomplish the following objectives:

- To restore the natural role of fire into the communities
- To reduce fuel loadings and therefore reduce the threat of destruction from wildfires
- To minimize char on redwood trees

The variety of communities in Muir Woods calls for a variety of prescription parameters. Prescriptions to be used are found in the prescription information section (Appendix F).

Initial burns are being conducted to determine fire behavior and fire effects. Established trails, roads and natural features will be used as fire lines. Burns are from 5 to 20 acres. Charring is monitored and the removal of materials from the base of certain trees may be necessary.

Fire Ecology

The many fire-scarred trees in Muir Woods provide evidence of historical fire occurrence. The last recorded fires occurred in 1800 on the valley floor (Sudborough 1966) and 1850 on the slope (Cornelius 1969). The most complete fire history in Marin County redwood communities was done using fire scar data from redwood stumps (McBride & Jacobs 1978). This study was conducted on two study sites: Old Mill Creek and Alpine Dam. Average fire return intervals of 21.7 and 27.3 years occurred respectively. The difference between these intervals was attributed to climatic moisture differences between sites (Jacobs et al. 1985). It should be noted however, that fire scar data can give conservative

estimates of fire frequency since low intensity fires occur which do not always scar the trees.

These aforementioned fire intervals are post human settlement. The available evidence indicates that the "natural" mean fire interval in the southern redwood forests is 50-300 years and the presence of humans has caused the decrease in the mean fire interval (Langenheim et al. 1983). Veirs (1980) has found that redwood forests in northern California have not significantly changed as a result of fire suppression, and were not adversely affected by the period of increased fire interval as most species have the ability to sprout.

At Redwood National Park it was observed that redwood is replaced by Douglas Fir and possibly other species after fire. Stone and Vassey (1968), however report that the exclusion of fire reduces the opportunity of redwood establishment but not the establishment of many competitors, and long-term fire exclusion could result in redwood replacement by other species.

The effect of fire intensity is important to the role of fire. Low intensity fires favor redwood rather than Douglas fir, while high intensity fires do the opposite (Veirs 1980). However, most large redwoods (greater than 20 cm DBH) survive prescription levels higher than those used in Muir Woods (Finney 1991). Fungal pathogens can enter redwoods through fire scars. This promotes rot in the heartwood. Although it is not fatal to the redwood, it places stress on the trees and increases the chance of wind breakage and damage by fire (Fritz 1932).

Seedling establishment requires bare mineral soil with adequate soil moisture which protects seedlings from attack by damping-off and root-rotting fungus (Davidson 1971). These environmental conditions occur after fire removes litter and sterilized soil, during periods when soil is exposed and when deposition of silt occurs on stream banks after floods. Another form of reproduction is vegetative sprouting which is triggered by mechanical injury, changes in light intensity, and fire (Simmons 1973).

Fire may play a primary role in redwood reproduction which is considered the primary objective with respect to the long term perpetuation of the community. Seedling establishment and sprouting seems to be stimulated by burning. However, at this time redwood regeneration at Muir Woods is adequate (McBride & Jacobs per. com. 1984).

Fuels Management

The fire hazard at Muir Woods has been analyzed by McBride and Jacobs (1978). Five major categories of fire hazard were identified: surface-fuel condition, ladder-fuel condition, downed woody fuel, slope-wind correlations and ignition risks (Figure 2).

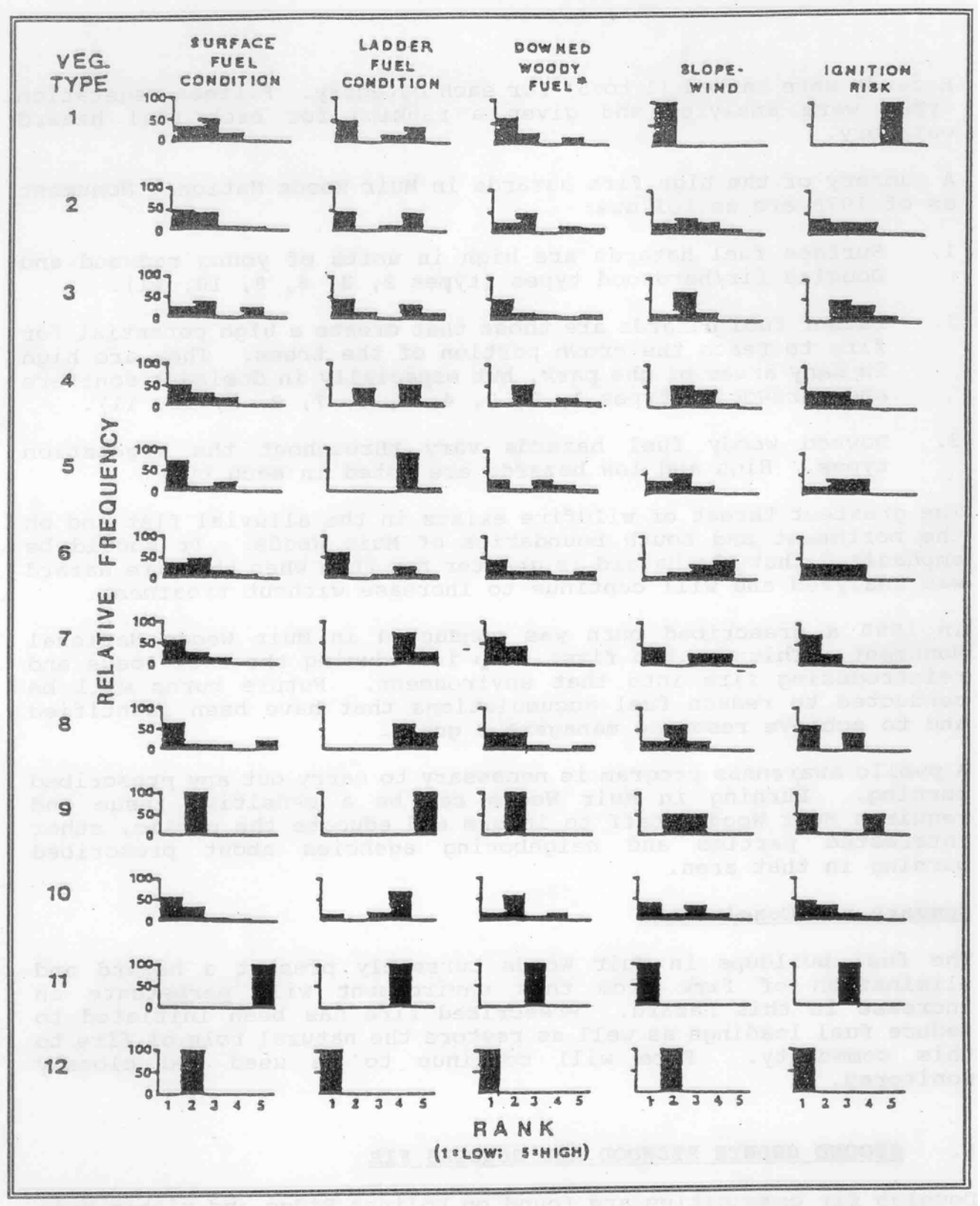

Figure 2. Fire Hazard spectra of vegetation types at Muir Woods (McBride & Jacobs 1978). Vegetation types: 1 – Redwood: alluvial; 2-Redwood; slope, old
Growth; 3-Redwood: slope, young growth; 4-Redwood/Douglas fir; 5-Redwood/hardwoods; 6-Douglas fir: old growth; 7-Douglas fir: young growth; 8-Douglas fir/hardwoods; 9-Douglas fir/brush; 10-Hardwoods; 11-Brush; 12-Grassland/brush; 13-Hardwood/brush; 14-Grassland.

Hazards were ranked (1 to 5) for each category. Fifteen vegetation types were analyzed and given a ranking for each fuel hazard category.

A summary of the high fire hazards in Muir Woods National Monument as of 1978 are as follows:

1. Surface fuel hazards are high in units of young redwood and Douglas fir/hardwood types (types 2, 3, 6, 8, 10, 11).

2. Ladder fuel hazards are those that create a high potential for fire to reach the crown portion of the trees. They are high in many areas of the park, but especially in dominant conifers and hardwoods (types 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11).

3. Downed woody fuel hazards vary throughout the vegetation types. High and low hazards are noted in each type.

The greatest threat of wildfire exists in the alluvial flat and on the northeast and south boundaries of Muir Woods. It should be emphasized that the hazard is greater now than when the fire hazard was analyzed and will continue to increase without treatment.

In 1985 a prescribed burn was conducted in Muir Woods National Monument. This was the first step in reducing the fuel loads and reintroducing fire into that environment. Future burns will be conducted to reduce fuel accumulations that have been identified and to achieve resource management goals.

A public awareness program is necessary to carry out any prescribed burning. Burning in Muir Woods can be a sensitive issue and requires Muir Woods staff to inform and educate the public, other interested parties and neighboring agencies about prescribed burning in that area.

Summary and Conclusions

The fuel buildups in Muir Woods currently present a hazard and elimination of fire from this environment will perpetuate an increase in this hazard. Prescribed fire has been initiated to reduce fuel loadings as well as restore the natural role of fire to this community. Fire will continue to be used and closely monitored.

E. SECOND GROWTH REDWOOD AND DOUGLAS FIR

Douglas fir communities are found on Bolinas Ridge and within Muir Woods. The communities on Bolinas Ridge have been logged. Douglas fir in Muir Woods sites have a brush understory and a significant component of dead fuel. Prescribed burning is recommended for these areas in the Muir Woods plan.

The objectives of burning within this community are to:

- Restore the natural role of fire into the community
- Reduce fire-hazards by reducing fuel loading
- Monitor the effect of fire on the community

Douglas fir/redwood communities are burned at the conservative end of the prescription with lower temperatures and higher relative humidities.

Fire Ecology

Douglas fir has thick bark when mature which acts as fire insulation to vital cambium tissues. Young Douglas fir are susceptible to fire and are often killed. Mortality increases with scorch height, percent crown scorch and bole damage, but decreases with trunk diameter. In addition mortality following fall fires is slightly higher than spring fires (Ryan et al 1988). Douglas fir seeds ripen in burned cones and require relatively open conditions for reproduction (Franklin & Dyrness 1973); it is considered shade intolerant. It takes a severe fire to destroy the seed bank of Douglas fir. Following a light to moderate burn an adequate seed bank remains (Sawyer et al. 1977). An open environment is brought about by burning and Douglas fir germination is enhanced.

Douglas Fir/Redwood

Douglas fir will generally dominate the post-fire generation in this community. Other tolerant tree species such as redwood develop almost simultaneously (Lotan et al. 1981). The majority of herbs and shrubs associated with this community sprout following crown destruction by fire (Lyon & Stickney 1974). Seeds of some species (e.g., *Ceanothus spp.)* require heat treatment before germination.

Redwood needles are more flammable than Douglas fir (Table 2) and will burn with a higher relative humidity. The redwood bark chars even with low intensity fire. Charring can be reduced significantly by limited raking of litter 1-2 feet away from trees (Boyd 1984).

Table 2. RELATIVE FIRE RESISTANCE OF REDWOOD AND DOUGLAS FIR (Lotan 1981)

Thickness of bark of old trees	Resin in old bark	Tolerance		Relative inflammability of foliage	Degree of fire resistance
		Branch habit	Stand habit		
DOUGLAS FIR					
Extremely thick	Little	High and moderately open	Dense	?	High
REDWOOD					
Very thick	Moderately low and dense	Moderate	Moderate to dense	High	High

Summary and Conclusions

This community is found on some slopes of Muir Woods and on Bolinas Ridge. Fuel loadings are increasing and need reduction at both sites. Prescribed fire will be used to reduce the fire hazard by reducing fuel loadings and to restore the natural role of fire to the community.

F. EUCALYPTUS/OTHER EXOTICS

Many vegetative species have been introduced into Golden Gate National Recreation Area as ornamentals, wind breaks, shade or for pasture. Many of these exotics have escaped cultivation and are invading native communities. Some are very flammable. The objectives for use of prescribed fire on exotic species will be:

- To prevent populations from invading natural habitats
- To reduce the fuel loading and therefore reduce the fire hazard
- To determine the fire frequency needed to accomplish the first two objectives

Little research has been done on exotic f orbs such as thistle, poison hemlock and fennel. Prescriptions for such species are decided upon following examination of threatened native communities

and taking into consideration the contribution the exotics make to overall fuel loading.

Several stands of blue gum **(***Eucalyptus globulus*) are found in Golden Gate National Recreation Area. The stands typically occur near former ranchlands and along park boundaries, usually planted as windbreaks (SWA Group 1975). Since the trees were established in the mid 1800s, two problems have developed: (1) the build up of flammable fuels in proximity to urban areas and (2) the encroachment of the eucalyptus on native plant communities.

Fire Ecology

Blue gum is an inhabitant of the dry sclerophyll forest in Tasmania and southern Victoria, Australia where fires are less intense than eucalyptus fires in California. Most eucalyptus tree species evolved under a frequent fire regime in Australia. Eucalypt adaptations to moderate and intense fire are many (Gill 1975): (1) growth to great heights is rapid and keeps limbs from exposure to fire, (2) bark thickness resists fire, (3) seed capsules are fire resistant, (4) seed fall is intense after fire, (5) intense fire prepares the best seedbed, (6) seeds germinate quickly in response to intense fire, (7) epicormic shoots and lignotubers sprout after intense fire.

A light fire is not as advantageous to eucalyptus for several reasons (Mount 1969): (1) fewer seeds germinate, (2) the seedbed is not as good, (3) soil moisture is lower, (4) less light is available, (5) more fungus are present. The "ash bed" effect also contributes to low germination and sprouting (Hatch 1960; Pryor 1960; Cromer 1967). Part of this effect is the removal of seedling and sprout inhibitors at the soil surface when litter is burned. Severe fires remove more of these inhibitors than light fires.

Prescribed fire in eucalyptus needs to be of low intensity in order to reduce the fuel loading. Frequent burns are needed to keep regeneration low. The desired burn frequency are determined as burn data is compiled.

Low-intensity spring burns are not particularly beneficial for eucalypt regeneration (Mount 1969). However, according to Boyd (1984) and Davis (1984), initial burns are apt to have more sprouts than follow up burns (Boyd 1984; Davis 1984).

Since a severe fire regime is more advantageous than no fire at all, this eucalyptus community can be called a fire-maintained community. Such communities tend to have adaptations which allow them to burn more readily than other communities. Eucalyptus in particular produces a ground fuel with high energy potential to insure flammability (Mutch 1970).

The fuel beneath Golden Gate National Recreation Area eucalyptus

stands have been accumulating despite decomposition. Organic matter in eucalyptus soil accumulates slowly and litter decomposition remains as duff, sometimes one foot deep (Mount 1969). All eucalypt studies indicate that the amount of available fuel on the forest floor is one of the most significant factors influencing fire spread and fire intensity (McArthur 1962; Cheney 1988) .

An extreme fire hazard is apparent in Marin County (Howell 1982). Similar eucalypt stands in the Berkeley hills show 45 to 100 tons/acre of ground surface fuels (Agee et al. 1973).

A hazard fuel reduction program using prescribed fire and mechanical manipulation will continue to be implemented in Golden Gate National Recreation Area eucalypt stands to reduce fuel buildups and lessen the fire hazard.

Summary and Conclusions

Blue gum has caused an extreme fire hazard in Golden Gate National Recreation Area due to the nature of fuels beneath it. It is also invading native communities. Literature indicates that the species is adapted to intense fire but that low-intensity fire adversely effects regeneration. Prescribed fire will be used to contain populations and reduce fuel.

VII. FIRE MANAGEMENT AND RESPONSIBILITIES

Organization

Superintendent
The Superintendent is responsible to the Regional Director for the implementation of all fire management activities within the park, including cooperative activities with other agencies or landowners in accordance with various delegations of authority. The Superintendent has designated full authority to the Chief Ranger, Park Operations Division, for all direct fire control activities and holds him/her responsible for accomplishments and results.

Chief Ranger
As head of the Park Operations Division, the Chief Ranger is responsible to the Superintendent for all fire prevention and suppression activities. The Chief Ranger of Park Operations supervises the fire management program and has delegated authority for all direct fire control activities to the Fire Management Officer.

Fire Management Officer
Responsible to the Chief Ranger for the management of all fire related activities.

Fire Effects Monitors
These monitors are responsible for conducting the field work necessary to carry out the Western Region prescribed fire effects monitoring program. They are concerned with fire effects, pre- and post-burn monitoring, fire weather and fire behavior monitoring prior to and during prescribed burns. They are under the direct supervision of the Fire Management officer, but will consult with the other Resource Management Specialists on questions involving resource issues.

Fire Control Aids
The Fire Control Aids are under the direct supervision of the Fire Management Officer. Their duties consist of many phases of fire control and they may be assigned to patrol or suppression crews. They are also responsible for fire equipment maintenance, presuppression and prevention activities.

District Rangers
District Rangers are delegated to submit reports on fire suppression within their districts. District Rangers shall respond to all fires.

Permanent and Seasonal Rangers
These people will function as assigned on fires according to their qualifications and training.

Safety Officer

The Safety Officer is responsible for ensuring that safety is a priority concern. Unsafe acts and safety hazards are eliminated and proper safety training is implemented.

Qualifications/Training

All National Park Service fire fighters will follow the current National Interagency Fire Qualification System (NIFQS). This establishes training and experience required to attain the different levels of fire qualifications.

Prescribed burning qualifications for Prescribed Fire Manager, Prescribed Burn Boss and Crew Member are included in Appendix H.

Cooperating Agencies

Interagency cooperation with the California Department of Forestry, County Fire Departments and City Fire Departments is critical to the successful implementation of this plan. Agreements are included in Appendix K.

Fire protection for lands south of the Golden Gate Bridge in Golden Gate National Recreation Area are maintained by fire suppression agreements with the California Department of Forestry, the City of Pacifica, and the Presidio Fire Department. Protection for lands located north of the Golden Gate Bridge are maintained by fire suppression agreements with the California Department of Forestry, Marin County Fire Department, Mill Valley Fire Department, Tamalpais Fire Department, Bolinas Fire Department, Stinson Beach Fire Department, Muir Beach Fire Department, and Sausalito Fire Department. These agreements are maintained on a 5 year cycle.

Annual Joint Operating Plans are maintained with the California Department of Forestry (Region I and the San Mateo/Santa Cruz Ranger Unit) and the Presidio Fire Department.

Other contacts for coordination and cooperation of fire suppression and other related fire projects are maintained with San Mateo County Fire Department, Menlo Park Fire Department, San Carlos Fire Department, San Bruno Fire Department, San Francisco Watershed, California Department of Parks and Recreation, City of San Francisco, Marin Municipal Water District, Marin Open Space District, and the U.S. Forest Service (Region 5).

VIII. WILDFIRE PROGRAM

A. Fire Prevention

The following are the primary objectives of the National Park Service wildfire prevention program:

1. To establish active wildfire prevention programs at the national, regional and park levels

2. To develop and implement a Service-wide prevention analysis process

3. To identify specific prevention alternatives in the fire management plan

4. To integrate and coordinate prevention programs with state foresters, adjacent land management agencies and wildfire protection organizations.

The specific fire prevention objectives of this fire management program are:

1. To develop and implement a defensible space program for structures

2. To develop a fire prevention program for trailheads and campgrounds by conducting an analysis of each specific site and implementing. vegetation clearance programs, public information programs and enforcement programs

3. To provide specific fire prevention *information to* the public through information outlets, such as visitor centers and public meetings

5. To develop a parkwide Wildfire Prevention Analysis

6. To develop Cooperative Agreements and *annual operating* plans with local fire agencies

7. To implement area restrictions and closures during extreme fire *conditions.*

The fire prevention program also includes more specific activities listed in the Presuppression section of this document.

A fire prevention analysis will be conducted in 1992 following the guidelines established in the revised NPS-18 and detailed in the NPS Prevention Analysis Handbook. This analysis may change or further define prevention activities and responsibilities within the park. When the analysis is completed it will be added as an

appendix to this fire management plan. Changes to this section of the fire management plan are identified through the analysis process and updated yearly if necessary.

B. Fire Behavior Predictions

Golden Gate National Recreation Area has a mediterranean climate consisting of a cool damp winter, a spring consisting of sunny, windy cool weather, a summer season of no rain but an unpredictable coastal fog influence and a dry hot fall. The seasonal characteristics of the weather along with the many different vegetation types determine the predicted fire behavior.

There are generally 7 major fuel types. Each fuel type has a unique fire behavior depending on the season of the year.

1. Grassland

   After the grasses have cured in the beginning of May, the grass fuels have the ability to carry fire among or to other vegetation. These fuels are very flashy and will spread fire very quickly. The grasses remain a major carrier of fire from May through November.

   Fires are surface fires that move rapidly through cured grass and associated materials.

2. Coastal Scrub

   The coastal scrub fuel type remains in a semi-fire resistant state until the fall of the year when the live fuel moistures drop and the fuels can produce fire with flame lengths of 1220 feet. The fuel normally does not present a fire behavior problem unless it is in the fall of the year when live fuel moisture drops below 90% or it is burning in a slope and preheating the fuels above it.

3. Eucalyptus

   Eucalyptus can be expected to produce an intense fire any time after the surrounding grasslands have cured. The dead and down fuel buildups can be expected to be 125 tons/acre or higher. This fuel does not have a fuel model that represents it. The trees have ladder fuels of shedding bark that produces torching and the very high potential of a crown fire. In December, 1990 the Recreation Area experienced a hard freeze causing large scale leaf and limb damage to eucalyptus groves. This freeze damage has significantly contributed to increases in aerial and ground fuels.

4. Oak Woodland

   The coast live oak communities support little ground fuel (probably less than 5 tons/acre) (Plumb, 1980), and as a result associated fire intensities are minimal. The exception

is where eucalypts are invading oak woodland. Here, this community has become more susceptible to fire than it has been historically.

5. Redwood/Douglas Fir

These forests have developed a large fuel buildup due to years of fire suppression. The fuel accumulations around the base of redwood trees provides fuels that will produce fire intensity causing fire to climb up the trunks of individual trees. The douglas fir trees have very significant ladder fuels that will contribute to fire being carried high into the trees. A fall season fire in this forest can be expected to produce a crown fire. This type of fire is difficult to control, requiring a backing off or containing strategy. Past prescribed fire experience in this fuel type produced fire climbing the bark of trees and burning for hours in the tops of the trees.

6. Douglas fir

This fuel type normally produces slow burning ground fires with low flame heights. The fire may encounter occasional "jackpot" or heavy fuel concentrations that can flare up. Under hot fall weather conditions extreme fire behavior can exist.

7. Chaparral

This fuel type produces a high fire intensity with fast spreading fires involving the foliage and live and dead fine woody material in the crowns of a nearly continuous secondary overstory. The fire behavior can be expected to be erratic and extreme when live fuel moisture drops below 90%.

Decadent stands located on steep slopes, like the one that exists on Bolinas Ridge, present an extreme fire behavior potential.

Young growth chaparral stands, like the one that exists in the Gerbode valley, show evidence of recent fire and do not present a current potential for extreme fire behavior.

C. **Presuppression**

Presuppression is defined as work done in advance of wildland fire occurrence to ensure effective suppression action. This activity includes: recruiting seasonal help, training, planning, maintaining the fire cache and procuring equipment and supplies.

1. Training

Annual fire training includes a minimum of one-half day fire refreshers for all park fire personnel and a basic fire class

consisting of S-130 and S-190. These are taught by the fire management officer and include instructors from Golden Gate as well as other parks and agencies.

Golden Gate National Recreation Area has become a wildfire training center for Western Region. Wildfire training academies are presented annually.

2 Fire Cache/Supplies

Golden Gate National Recreation Area maintains three district fire caches and a Western Regional fire cache.

Two of the district fire caches are managed by district personnel with annual inventory and maintenance conducted by the Fire Management Office. In May of each year, each district fire cache is inventoried and equipment is checked for condition and operational readiness. This includes tool sharpening and the running and service of any pumps and/or saws.

The park has three slip-on units that are installed in May and removed at the end of the fire season, usually in November or December. Annual service and maintenance is provided by either park mechanics or local contract.

The Western Regional fire cache support crew mobilizations. Equipment is maintained by the lead fire aid. The regional cache includes saw kits and radios. Saws are maintained by local contract.

3. Patrols

Increased patrols will be conducted when the fire danger rating reaches high or above. Patrols for added fire detection and increased initial attack capability will be conducted by fire management staff. Personnel will patrol in 4-wheel drive vehicles with slip-on units.

There are three lookouts that are operated by local fire agencies. These are not always in operation and are predicted to be cut from local budgets in 1992.

Due to the geography and public access, 90% of wildfires are reported by park visitors or park neighbors.

More specific fire prevention and presuppression activities will include:

- Maintenance of established fire breaks each year prior to fire season.

- Mowing and clearing brush from road edges.

- Establishing fire breaks within the Eucalyptus grove in close proximity to Highway 1.

- Where it is deemed necessary, clearance of debris and cured vegetation from structures.

- Limiting campfires to established fire pits in designated campgrounds. However, open fires of any type may be prohibited by the Fire Management Officer.

- Posting "Fireworks Prohibited" signs from July 1 to July 8 at all park entrances.

- Posting "No Smoking" signs at trailheads.

- Maintenance of a Fire Weather Station at Muir Woods. Daily fire weather will be evaluated by WIMS or NFDRS to determine the Burning Index. The Fire Management officer will determine the need for standby personnel and when to initiate a step-up plan. The Superintendent will be advised of adverse conditions and will determine what road and trail closures will take place. The local media will be contacted if and when closures are established.

D. Emergency Presuppression

Fire management staffing levels during fire season are determined by the local Burning Index (BI) calculated from the National Fire Danger Rating Systems local fire weather and fuel moisture inputs. The following step-up plan reflects the preparedness levels used by Golden Gate National Recreation Area:

Staffing Class I:
Burning Index: 0 - 13
Fire Danger Rating: Low

Normal operations. No special manning requirements.

Staffing Class II:
Burning Index: 14 - 27
Fire Danger Rating: Moderate

Normal tour of duty. Minimum of two firefighters (one squad boss qualified) per district.

Staffing Class III:
Burning Index 28 - 55
Fire Danger Rating: High

Normal tour of duty. Minimum of two firefighters (one squad boss qualified) per district. Contacts are made with local cooperating fire agencies for notification of high fire danger and discussion of any current logistic issues. Fire aids patrol area and remain available for initial attack. Fire aids work until one hour after sunset.

Staffing Class IV:

Burning Index:	56 - 117
Fire Danger Rating:	Very High

Tours of duty extended. District fire personnel available for initial attack. Fire management personnel available for initial attack with day schedule extended until one hour after sunset. Contacts are made with local cooperating fire agencies. Patrols of area are conducted with slip-on units. "High Fire Danger" signs are posted by fire management staff.

Staffing Class V:

Burning Index:	118+
Fire Danger Rating:	Extreme

All Manning Class IV actions, plus:
Possible closure of trails, fire roads and campgrounds. Local cooperating fire agencies will be informed of any closures.

E. Fire Detection

Detection of fire and subsequent dispatch of necessary suppression personnel is the responsibility of the Fire Management Officer. Detection of wildfire can come from a variety of sources at Golden Gate National Recreation Area.

Golden Gate National Recreation Area is adjacent to large urban areas. Past fires have been reported by park visitors, park neighbors, or park personnel. During fire season, a fixed lookout on Mount Tamalpais is staffed by Marin County. This lookout will normally be able to detect any smoke within the Marin Unit. San Francisco Watershed personnel, California Department of Forestry personnel and local citizens have been responsible for the detection and reporting of fires in San Mateo County.

During high fire danger periods increased patrols are conducted.

All reports of fire spotted by any detection source will be immediately reported by radio or telephone to Park Police Dispatch. Park Police Dispatch will initiate a call to the appropriate fire agency. Park police dispatch will then notify the Fire Management Officer and District Ranger.

F. Pre-Attack Plan

One of the objectives of fire management is to suppress wildfires at minimum cost while minimizing the impacts from suppression activities. The pre-attack Emergency Fire Situation Analysis (EFSA) located in Appendix G translates park fire management objectives into an action document which determines initial suppression strategy. The pre-attack EFSA will serve as the framework for an EFSA if the fire exceeds the parameters of the selected suppression alternative.

Appendix I provides a Pre-Attack Planning Checklist that will be used for planning of suppression activities.

G. Fire Suppression

The objective of fire suppression at Golden Gate National Recreation Area is to suppress wildfire at minimum cost consistent with values at risk, while minimizing the impacts from suppression activities.

The confine, contain, or control strategy will be used in the suppression of all wildfires. Due to the subtle differences and past confusion of this strategy, the following definitions are used:

- Confine: to restrict the wildfire within determined boundaries, established either prior to, or during the fire. These identified boundaries will confine the fire, with no action being taken to put the fire out.

- Contain: To restrict a wildfire to a defined area, using a combination of natural and constructed barriers that will stop the spread of the fire under the prevailing and forecasted weather conditions, until out.

- Control: To aggressively fight a wildfire through the skillful use of personnel, equipment and aircraft to establish firelines around a fire to halt the spread and extinguish all hot spots, until out.

Due to the boundaries and values at risk the majority of wildfires will be suppressed using the control strategy.

The lands within Golden Gate National Recreation Area are comprised of recently acquired areas within complex boundaries and multiple jurisdictions. Fire fighting within these areas is the responsibility of many different fire fighting agencies. The Recreation Area is bordered by many adjoining cities, towns, and unincorporated areas, each of which has agencies responsible for fire protection in their area.

Wildfire suppression on National Park Service lands in Golden Gate National Recreation Area will be primarily accomplished by the local fire agency of jurisdiction. The National Park Service will supplement local fire suppression forces through providing fire personnel and technical support. Through cooperative agreements, NPS personnel and equipment are available for suppression assignments on adjacent lands.

Golden Gate National Recreation Area has established interagency fire fighting agreements with Marin County Fire Department, Bolinas Fire Protection District, Sausalito Fire Department, Tamalpais Fire Protection District, Muir Beach Volunteer Fire Department, Mill Valley Fire Department, Stinson Beach Fire Protection District and the Presidio Fire Department (Appendix K). San Francisco area fires are suppressed by the Presidio and San Francisco Fire Department. No formal agreement with San Francisco Fire Department currently exists. Suppression on San Mateo County lands is a joint responsibility of California Division of Forestry and local fire departments.

In accordance with cooperative agreements, Marin County Fire Department will be the primary wildland fire suppression agency on lands north of the Golden Gate Bridge. Golden Gate National Recreation Area (Fire Management Officer) and Marin County Fire will establish a joint command on any fires that occur on or adjacent to park property. The park will provide personnel and equipment for all initial or extended attack wildland fires. During wildfires the fire management office will assemble and coordinate resource assignments. On extended attack resource requests not filled by the two agencies will be requested and filled through the Marin County Dispatch.

On lands south of the Golden Gate Bridge, the San Mateo County, California Department of Forestry will be the primary wildland fire suppression agency. When wildfires occur on or adjacent to park property a joint command will be established with San Mateo County, California Department of Forestry and the National Park Service (Fire Management Officer). The park will provide equipment and resources for initial attack or extended attack wildfires on or adjacent to park property. The fire management office will assemble and coordinate resource assignments. On extended attack resource orders not filled through the two agencies will be placed through San Mateo County, California Department of Forestry.

The Fire Management Officer, or an agency representative assigned by the fire management office, will be assigned to any extended attack fire for the duration of the fire.

Any extended attack suppression action that takes place on park property will have an "Escaped Fire Situation Analysis" completed to guide the re-evaluation of suppression strategies. (Appendix G).

Any wildland fire requiring extended attack will require a "Limited Delegation of Authority." A draft document has been prepared and is on file in the fire management office.

The Fire Management officer or his/her representative retain the authority to evaluate resource related values and determine whether heavy equipment or air drops are appropriate during fire suppression.

Golden Gate National Recreation Area personnel involved in fire fighting along with the other local fire fighting agencies are trained in and use the Incident Command System when responding to fires within the park boundary. This is followed in accordance with ICS 420-1, dated September 1983.

The California Department of Forestry maintains two tanker bases that can support fire suppression actions within 30 minutes of notification. They also maintain nine vans and 500 equipped people and can be anywhere in northern California within 3 hours.

The National Park Service has adopted the National Interagency Incident Management Command System (NIIMS) as its system for management of wildland fires.

H. Rehabilitation

Rehabilitation is defined as any action taken to restore an incident area to its pre-burn or natural condition. Such actions are initiated once all primary suppression objectives have been achieved, but may be initiated prior to the fire being declared out. If the most appropriate suppression strategies are selected by the incident overhead team, only minimum rehabilitation efforts are usually necessary. The use of wet lines, streams and other natural fire breaks along with the careful selection of artificial fire line to avoid densely forested areas, etc., are methods which contribute to this goal.

All acreage impacted by suppression efforts will be rehabilitated in accordance with the NPS-Western Region Wildland Fire Resource Advisors Task Book (1992). Rehabilitation guidelines from this handbook are found as Appendix J.

I. Records and Reports

Situation Report

This report will be updated on a daily basis during fire season (May 1 - November 30). It will be entered in the National Park Service Wildland Fire Computer system by the fire management clerk.

Individual Fire Report Records
These will be completed by the District Ranger or his/her representative. The reports will be submitted to the Fire Management Office for entry into the National Park Service Wildland Fire Computer System.

Fire Weather Records
Fire weather will be entered daily into the WIMS computer system during fire season (May 1 to November 30). This is the responsibility of the fire management clerk.

Individual Wildland Fire Training and Experience Entry Records
These records will be entered and updated as necessary in the National Park Service Wildland Fire Computer System. This will be done by the fire management clerk.

Training Needs Analysis
These reports will be accessed by the fire management clerk in the National Park Service Wildland Fire Computer System as requested by the Fire Management Officer.

Hazard Fuels Project Requests and Completion Reports
These requests will be written by the Fire Management Officer and entered into the National Park Service Wildland Fire Computer System by the fire management clerk.

Mutual Aid Agreements
These will be written by the Fire Management Officer as needed.

Annual Operating Plans
These will be written by the Fire Management Officer each year before May 1.

IX. MANAGEMENT IGNITED PRESCRIBED FIRE/PRESCRIBED BURN PROGRAM

In 1990 Golden Gate National Recreation Area received funding for a fire management program. Fire prevention, fire protection, fire suppression and prescribed fire are all parts of the program. The prescribed fire portion of the program began in 1985. In 1990 the program added the Western Region Fire Monitoring Handbook techniques which direct the collection of biological data related to prescribed fires. The vegetation types identified within the six fire management units include:

- Northern coastal scrub
- Northern coastal prairie
- Broadleaf Evergreen Forest
- Redwood Forest
- Chaparral
- Non-native perennial grassland
- Non-native annual grassland
- Non-native thistle

Permanent transects will be established in each of the listed vegetation types. The data collected provides information on species composition, live-to-dead ratio, fuel loading and brush density. This information is entered into a custom computer program. The computer program stores the data and performs analysis. After burning, the transects are scheduled to be re-read at the following intervals:

- After burning (within 2 months)
- 1 year after burning
- 2 years after burning
- +45 years after burning
- 10 years after burning
- every 10 years after burning

This program allows for the identification of vegetation changes over time. Prescribed fire is used to achieve identified management goals in each of the vegetation types. The short and long term effect of fire on the different vegetation types will be evaluated using the Western Region Fire Effects Monitoring Program and adjacent control plots.

The following prescribed fires are proposed over the next 5 years. Other prescribed fires may be proposed during this same time period if deemed necessary.

YEAR 1 or 2

1. Sweeney/Baquiano Burn

This burn block is located in the Sweeney Ridge portion of the Recreation Area. It is adjacent to the historic Portola

discovery site.

This area is a combination of Northern Coastal Scrub and Northern Coastal Prairie and non-native annual grassland.

Sweeney Ridge is quickly losing all grasslands to coastal scrub and brushland. The historic scene experienced by Portola has been converted from grass covered hills to brush. This conversion of vegetation also increases the likelihood of unmanageable wildfires and degrades the diverse wildlife habitat.

Fire will assist in restoring the area to the condition that existed when Portola experienced it on November 4, 1769. Fire will reduce the brush and lessen the hazard fuel buildup. It will also improve the diversity of the habitat benefiting both plants and animals.

2.Milagra Ridge Burn

This burn block is located within the Milagra portion of the Recreation Area.

This area is a combination of Northern Coastal Scrub and Northern Coastal Prairie and non-native annual grassland.

This area has been heavily impacted by past military activity and current renegade recreation activities. The grassland areas of Milagra Ridge are habitat for the endangered Mission Blue Butterfly. The area is quickly losing all grasslands to coastal scrub, brush and exotic plants and the habitat for the Mission Blue Butterfly (Icaricia icarioides missionersis) is quickly being destroyed by these changes.

Fire is an important part of the natural history of several species of Blues (Stewart and Ricci 1988) and has been shown to be an essential part of the ecology of butterflies that have coevolved with larvae-tending ants (Ross 1966). Fire will assist in the reduction of brush buildup and aid in protecting the grassland habitat of the Mission Blue Butterfly. It will also enhance the habitat for other mammals, birds and insects by maintaining a diversity of vegetation.

3. Bobcat/Alta Burn

This burn block is located at the intersection of Bobcat Trail and the Alta Avenue Fire Road within Marin Headlands District of the Recreation Area.

This area is a combination of Northern Coastal Scrub and Northern Coastal Prairie.

This area is quickly losing all grasslands to scrub and brush. In 1989 a prescribed fire was conducted at this site. The fire was conducted under conditions that achieved some, but not all, goals. Due to the prescription, the goals of coastal scrub modification and brush reduction were not achieved.

In order to achieve brush reduction and coastal scrub modification, prescription elements have been modified and burn preparation techniques added. This prescribed fire will assist in the modification of coastal scrub, reduction of brush and aid in the restoration of grasslands and native species.

4. Tennessee/Coastal

This burn block is located in the Tennessee Valley portion of the Recreation Area.

The vegetation is Northern Coastal Scrub and Northern Coastal Prairie.

The Golden Gate National Recreation Area Management Plan identifies this as an area to be maintained as a "pastoral" environment. This area was heavily grazed by cattle from the 1950's until 1984. The cattle had a major effect on soils as well as vegetation. Coastal scrub and brush is quickly taking over grasslands and destroying the "pastoral environment". This particular burn site is located on a southwest facing aspect that would normally be the most resistant to brush buildup due to shallow soils, less moisture availability and greater exposure to ultra-violet light.

Prescribed fire in this area will discourage further encroachment by coastal scrub and brush, and encourage grasses. Fire will aid in maintaining grasslands and a pastoral environment, as well as encouraging diversity of vegetation and improvement of wildlife habitat.

5. Coyote Ridge/Fox Burn

This burn block is located at the intersection of the Fox and Coyote Ridge trails within the Recreation Area. This ridge top location consists of non-native annual grassland and northern coastal prairie.

This site is an excellent example of native northern coastal prairie. It is being overtaken by aggressive non-native

grasses.

Prescribed fire will be used to encourage the native grasslands and discourage non-native grasses and brush.

6. Willow Camp Burn

This site is located on the slope above the town of Stinson Beach and below Bolinas Ridge.

The major vegetation at this site is the non-native species, Harding Grass, and other native and non-native grasses.

Harding grass is taking over the grasslands by out-competing the native grasses.

Prescribed fire in the fall of the year will encourage the existing native grass seed to germinate and discourage the expansion of the non-native species.

YEARS 2 TO 5

1. **Tennessee/ Chaparral** - non-native annual grassland/ northern coastal prairie.

2. **Tennessee Valley** - non-native annual grassland/northern coastal prairie.

3. **Gerbode Valley** - non-native annual grassland/non-native perennial grassland.

4. **Oakwood Valley** - non-native forest/oak woodland/northern coastal prairie/non-native annual grassland.

5. **Miwok/Coyote** - non-native grassland/northern coastal prairie/northern coastal scrub.

6. **Coastal/Rifle** - non-native grassland/northern coastal prairie/northern coastal scrub.

7. **Deer Park/Dipsea North** - redwood forest/douglas fir forest.

8. **Deer Park/Dipsea South** - bay woodland/douglas fir forest.

9. **Panoramic/Lost** - chaparral/oak woodland.

10. **Redwood** - redwood forest.

11. **Bolinas/Fairfax** - northern coastal scrub/northern coastal prairie.

12. **Whitegate** - non-native grassland/northern coastal prairie.

Burning in the 8 different vegetation types will accomplish many management goals, encouraging native species, enhancing wildlife habitat, controlling exotic species, maintaining a mosaic of vegetation, restoring natural processes and reducing hazard fuel buildup.

Table 3. FIVE YEAR BURNING PLAN

GOLDEN GATE NATIONAL RECREATION AREA
FIVE YEAR BURNING PLAN
FY 1993-1997

FY of Burn	Burn Name	Project #	# of acres	FMU within approved FMP	WR Fire Effect Monitoring Type
1993	Bolinas/Fairfax	9201R	10	Grassland and Coastal Scrub	Non-native annual grassland; northern coastal prairie
1993	Whitegate	9292R	15	Grassland and Coastal Scrub	Non-native annual grassland; non-native annual thistle
1993	Sweeney Ridge	9203R	2	Grassland and Coastal Scrub	Non-native annual grassland; northern coastal scrub
1993	Deer Park/ Dipsea North	9202H	5	Second Growth Redwood & Douglas Fir	Redwood forest; Douglas Fir forest
1993	Coyote/Fox	9204R	3	Grassland and Coastal Scrub	Non-native annual grassland; northern coastal prairie
1993	Tennessee/Coastal	9203H	35	Grassland and Coastal Scrub	Non-native annual grassland; northern coastal prairie; northern coastal scrub-coastal prairie mosaic
1993	Coastal/Coyote	9205R	5	Grassland and Coastal Scrub	northern coastal prairie
1994	Milagra Ridge	9301R	4	Grassland and Coastal Scrub	Non-native annual grassland; northern coastal scrub (southern phase)
1994	Bobcat/Alta	9302R	5	Grassland and Coastal Scrub	Non-native annual grassland; northern coastal prairie; northern coastal scrub
1994	Tennessee/Chaparral	9303R	25	Grassland and Coastal Scrub	Non-native annual grassland; northern coastal prairie
1994	Gerbode Valley	9304R	15	Grassland and Coastal Scrub	Non-native perennial grassland; non-native annual grassland
1995	Deer Park/ Dipsea South	9301H	10	Broadleaf Evergreen Forest	Bay woodland
1995	Mori Point	9401R	6	Grassland and Coastal Scrub	Non-native annual grassland
1995	Tennessee Valley	9402R	5	Grassland and Coastal Scrub	Non-native annual grassland; northern coastal prairie
1996	Miwok/Coyote	9501R	3	Grassland and Coastal Scrub	Non-native annual grassland; northern coastal scrub
1996	Oakwood Valley	9401H	15	Eucalyptus: Other Exotics	Non-native forest
1996	Bolinas Ridge	9402H	25	Chaparral	Maritime chaparral

Table 3. FIVE YEAR BURNING PLAN, (cont.)

FY of Burn	Burn Name	Project #	# of acres	FMU within approved FMP	WR Fire Effect Monitoring Type
1997	Panoramic/Lost	9601R	15	Chaparral; Broadleaf Evergreen Forest	Manzanita chaparral; oak woodland
1997	Redwood	9501H	5	Old Growth Redwood	Redwood forest
1997	Baquiano Hill	9602R	2	Grassland and Coastal Scrub	Non-native annual grassland; northern coastal scrub
1997	Coastal/Rifle	9603R	3	Grassland and Coastal Scrub	Non-native annual grassland; northern coastal scrub
1997	Sweeney/Mori	9604R	1	Grassland and Coastal Scrub	Northern coastal scrub

Preburn Responsibilities

Prior to writing a burn plan the District Ranger will be notified by the Fire Management Officer of the proposed prescribed burn. The burn will be discussed and upon agreement with the District Ranger, a burn plan will be written. All burn plans will be written in accordance with the National Park Service Prescribed Burn Unit Plan. The burn plan will be submitted to the Project Review Committee. After the committee reviews and approves the proposal, the burn plan will be given to the Superintendent for signature of approval.

All political and logistical requirements will be identified and met with a coordinated effort by the District Ranger and Fire Management personnel.

Monitoring of all prescribed fires will be conducted in accordance with the Western Region Fire Monitoring Handbook. This includes installation of vegetation monitoring plots prior to burning, monitoring of fire behavior, including weather and smoke during the burning, and the post fire monitoring of fire effects.

The annual burning program will be developed by the Fire Management Officer.

The Fire Management Officer will appoint one Burn Boss to implement each burn. The Burn Boss will be certified under the Western Region Prescribed Fire Certification System (See Training and Qualification section) and will be responsible for:

1. Writing the individual Burn Unit Plan in accordance with the standardized Prescribed Burn Plan Format (NPS-18, Section III, Chapter 5, Exhibit 3);

2. All pre-burn activities that are necessary;

3. Preparing a post-burn report and identify monitoring needs.

The Western Region Prescribed Burn Plan will be completed prior to any proposed use of prescribed fire. The plan will be approved by the Superintendent no less than 5 days before the planned ignition.

The burning prescriptions appropriate for each vegetative community are provided within the text of this plan. Prescriptions will be refined as burns are completed.

The prescribed burning program involves the collection of fire behavior and pre/post burn fire effects data on individual ecosystems. Burning prescriptions are refined continuously based upon this data. Small burn areas (1-35 acres) are used. Pre-burn data collection includes fuel loadings and plant species composition and density.

Fire weather and fire behavior are monitored during each burn. Fire behavior data collected includes flame length, rate of spread, flame height, flame zone depth, fuel moisture, and residence time. Fire weather data collected includes temperature, relative humidity, wind speed and direction. The smoke plume is monitored and photographed at different stages of each burn.

Post-burn data collection includes: scorch heights, fuel loading, char height, burn severity, plant species composition, dbh of tree species, plant species mortality and density. Observations of wildlife/ livestock use and erosion areas are made. A post burn analysis on data collected is attached to the burn plan for future reference.

At this time, the fire management program will become an annual process of using prescribed fire in accordance with the objectives defined in each Fire Management Unit. Fire behavior and effects will continue to be monitored indefinitely.

X. AIR OUALITY/SMOKE MANAGEMENT GUIDELINES

Air Ouality

Preservation of all the resources of Golden Gate National Recreation Area depends on good air quality. Protection and maintenance of resources in their natural state depends on minimizing all types of man-induced alterations, including the degradation of air quality. Air pollution, even at quantities below federal standards, can harm vegetation, degrade visual air quality and diminish visitor enjoyment.

Air quality in the San Francisco Bay Area is managed by the Bay Area Air Quality Management District. The Air Quality Management District has two procedures which must be followed by Golden Gate National Recreation Area.

Smaller fires (less than 100 acres) require only notification. A Burn Notification Form must be sent to the Management District when the prescribed burn is for the purpose of fire hazard reduction. Wildlife and forest management fires need no prior notification, however, a Burn Notification Form will be filled out for park files. These burns must occur on an "allowable" burn- day, defined by the Air Quality Management District. Notification of burn days can generally be obtained by 15:00 the day before the planned burn by calling 800-792-0787. Burns that are to occur on "no burn-days" must receive a variance from the Air Quality Management District. Post-burn, information on the fuels burned must be sent to the Management District. Cards for this purpose and Burn Notification Forms are obtained from the Bay Area Air Quality Management District, 939 Ellis St., San Francisco, CA 94109.

Larger fires require a formal process which involves the submission of the plan to the Air Quality Management District one month ahead of the proposed burning date. The District will then issue a forecast 72 hours prior to the proposed burn-day and give a commitment to a burn-day 48 hours prior to burning. This procedure allows flexibility in the preparation of burns greater than 100 acres.

Smoke management is important due to the proximity of an urban area. Wind direction and mixing heights are two key elements in smoke management. Mixing heights vary with the season. During the winter months there is often unlimited mixing during the day with low inversions (50 feet) at night. Inversions also occur in summer and early fall. These inversions are commonly at 1500 feet but get as low as 500 feet. Preferable wind direction is away from the urban areas.

The best burning situations are under unstable atmospheres with a wind flow away from urban zones. A favorable situation may occur with an inversion if an east wind exists. This occurs generally on

"no burn-days" and would need a variance from the Air Quality Management District.

Smoke Management

Smoke management will be a component of all prescribed burns and will be covered in the burn plan. Smoke management includes regional smoke dispersal as well as localized visibility questions. Smoke dispersal and column drift will be monitored during all prescribed burns. Wind directions that carry smoke away from adjacent communities are an important part of burn prescriptions. The Golden Gate National Recreation Area smoke management program includes the following constraints:

- Smoke drift will be plotted in relation to adjacent communities as part of each prescribed burn plan
- Burns will be planned for relatively unstable weather conditions to allow for good mixing
- Prescribed burns will receive total mop up when no burn days are forecasted for the day following the burn
- Spot weather forecasts will be obtained form the National Weather Service to better predict smoke drift/dispersal
- Smoke dispersal will be observed during the test burn stage to confirm smoke behavior
- The prescribed fire monitor shall observe smoke dispersal and mixing heights. The monitor shall keep the prescribed burn boss informed about smoke conditions and shall advise the burn boss if smoke is violating constraints set forth on the burn plan
- Prescribed firing techniques and fuel moisture conditions which minimize smoke production and duration and meet natural resource management objectives will be utilized. Fuel moisture will be as dry as seasonal weather allows prior to ignition
- Burns will be sized so they can be completed in one day whenever possible
- Roads where visibility and traffic safety are affected will be addressed in the prescribed burn plan of the affecting burn
- The affected road segment will be signed "Prescribed Fire in Progress," or if considered prudent the road will be closed during the burn

- Park personnel will be stationed at both ends of the affected road segment, they will be equipped with radios to maintain contact with each other and the prescribed fire manager during

the burn. These personnel will also keep the prescribed burn boss advised regarding smoke drift across the road

- The park will comply with the Clean Air Act, as amended, and local air quality control regulations (described above).

XI. FIRE RESEARCH AND MONITORING

Fire Research

The Western Region maintains strict guidelines governing the implementation of research burns. A formal proposal must be submitted and approved, in accordance with Western Region protocol for such burns, and must accompany a Western Region burn plan, which is prepared and implemented by a fully qualified NPS Prescribed Burn Boss.

Procedures for conducting research burns are stated in the Regional Director's memorandum dated February 7, 1990, file Y14 (WR-OR), subject: Research Burns. All phases of the burn's implementation process will be done in accordance with standards for such projects as described in NPS-18 (1990b). Additionally, pre- and post-burn monitoring or research **must** incorporate the minimum acceptable standards (MAS) for sampling design and techniques as stated in the Western Region Fire Monitoring Handbook (NPS 1992).

Fire Monitoring

National Park Service fire management guidelines (NPS-18, NPS 1990b) state that parks with prescribed fire programs must monitor those fires to ensure that fire behavior is assessed and resource management objectives are met. The Western Regional Fire Monitoring Program allows the National Park Service to document basic information, to detect trends, and to ensure that fire and resource management objectives are being met. From these identified trends park managers can articulate concerns, develop hypotheses, and initiate specific research projects to develop solutions to management problems.

The Western Regional Fire Monitoring Handbook (NPS 1992) has been implemented at Golden Gate National Recreation Area and Point Reyes National Seashore by a shared Fire Management Office. The procedures outlined in this handbook have been implemented for all national parks in the Western Region of the National Park Service that use fire as a management tool. This monitoring program is intended to facilitate and standardize fire monitoring throughout the region. Levels of monitoring activity are related to fire management goals and strategies established in each individual park. Procedures and required frequencies for monitoring are standardized.

All wildland fires, including prescribed fires and wildfires, will be monitored in accordance with the minimum acceptable standards (MAS) as set forth in the Western Region Fire Monitoring Handbook (NPS 1992).

XII. PUBLIC SAFETY

The Fire Management Officer will disseminate information on all potentially hazardous fires to all divisions and districts. The Fire Management Officer will make recommendations to the Recreation Area Superintendent through the Chief Ranger's Office on potentially hazardous situations.

All active fires will be routinely monitored and evaluated for safety as conditions change. If necessary, areas of the Recreation Area may be closed due to fire hazards (intense burning activity, dense smoke, etc.) as per recommendations found in the Western Region Fire Monitoring Handbook (NPS 1992). The Golden Gate National Recreation Area's Ranger Division and Park Police will be responsible for enforcing all closures.

The Burn Boss of any prescribed fire will insure that closure and informational signs on all prescribed fires are properly posted. All divisions will inform the public of potential dangers, closures and regulations in the course of all public contacts.

XIII. PUBLIC INFORMATION AND EDUCATION

Although the general public has in recent years become more informed about the role of fire in the ecosystem, the large number of catastrophic wildfires of, recent years has produced many concerns and fears. To reduce these public concerns and gain acceptance and support for this fire management program, the public must be kept informed of fire management goals, policies and activities.

There are three target groups with specific needs. Those groups include:

1. In-service personnel directly or indirectly involved in the implementation of the fire management program.

2. Related agencies, including those adjacent to our boundaries. These agencies are indirectly affected by any fire activity within the Recreation Area. They are directly affected by a variety of factors including:

   - Fire encroachment along boundaries
   - Visual effects of smoke
   - Use of their available personnel and resources, in support of the Recreation Area's fire activities
   - Regulatory agencies (Bay Area Air Quality Management District)

3. Visitor and general public including:

   - Recreation user public
   - Special interest groups
   - Local communities and park partners
   - Other members of the public

information Dissemination

Information responsibilities are displayed in Table 4.

In-Service Personnel

Keeping this group aware of fire management activities is essential to the effective dissemination of information to the general public. It is important to assure that the entire staff is familiar with the Fire Management Plan, the Recreation Area's role in wildfire suppression, and the employees' role within the fire management scheme. This is accomplished through an on-going education program, which includes training, employee meetings and active participation by Recreation Area staff in the fire program.

TABLE 4. INFORMATION RESPONSIBILITIES

Action Task	Person Responsible	Date
Public information via TV, radio, newspapers, agency station.	Public Information Officer	When notified
Public information and awareness via park rangers to park visitors and visual displays.	Division of Interpretation	On-going
Authors Prescribed Burn Plan	Fire Management Officer	Each burn
Inform agency personnel, crews, air quality and other necessary individuals prior to burning	Prescribed Burn Boss	As needed
Post "prescribed fire in progress" signs	Prescribed Burn Boss	Each bum

Responsibilities for Prescribed Fire and Fire Suppression operations are described in their respective sections.

Visitor and General Public

It is important to recognize the public's right to know and need to receive accurate information. The key person for general information dispersal will be the Public Affairs Officer, who will generate press and public information releases from information supplied by the Fire Management Officer. The Superintendent's office will assure prompt distribution of the pertinent fire information to both concession and in-holding operations.

The general staff, with Interpretation taking the lead, is responsible for dissemination of accurate fire information to the visiting public. This includes educating the public to the role of fire in Golden Gate National Recreation Area. Interpreters will inform the public of fire policy and status through talks and informal contact at the Visitor Center.

Related Agencies

State and local agencies have a vested interest in Golden Gate National Recreation Area activities. It is the Fire Management Officer's responsibility to assure that an open line of communication is maintained with all affected agencies.

Interpretation of Prescribed Fires

A regional slide/videotape, a Western Region brochure and a traveling visitor center photographic display interpreting National Park Service management of prescribed fire and prescribed natural fire are available through the Western Region Branch of Fire Management. A request for this material can be made, at no charge, through the Fire Management Officer.

XIV. ARCHEOLOGICAL,/CULTURALIHISTORIC RESOURCES

The prehistoric, historic and contemporary Native American cultural resources of Golden Gate National Recreation Area cover a time span of at least 2,000, and perhaps 6,000 years; although discontinuously.

Prehistoric

Evidence of Native Americans in Golden Gate National Recreation Area ranges from shell midden sites to Alcatraz graffiti. Six Miwok archeological sites occur in the Marin County area of Golden Gate National Recreation Area. Research has demonstrated that fire has little significant effect on midden sites. However, site locations will be taken into consideration during the planning phase of prescribed burns and appropriate measures taken so as to minimize impact by personnel and equipment. At this time, there are no prescribed burns planned near known midden locations.

These prehistorical resources are an important source of information vital to the understanding of local and regional prehistory and to theoretical and methodological questions of wider anthropological interest.

Historic

The historic resources represent the major stages of regional land use and economic history over the last 200 years. There are nearly 800 historic sites and structures within the park boundary which include: a prison, a lighthouse, old ranch houses, and military fortifications.

Properties listed on the National Register of Historic Places include:

- Forts Baker, Barry and Cronkhite
- The Presidio
- Fort Mason Historic District
- Fort Point Historic Site
- Point Lobos Archeological Sites

Protection of Golden Gate National Recreation Area archeological, cultural and historic resources is a park priority. Locations throughout the Marin area exist, however the archeological survey for San Mateo County lands is not complete. Archeological clearance must be given by the park Archeologist prior to each burn.

XV. FIRE CRITIQUES AND ANNUAL PLAN REVIEW

All fires, both wildland and prescribed, that occur on Golden Gate National Recreation Area lands will be reviewed.

An approving signature on a DI-1202 will serve as sufficient documentation of an informal review on simple fires involving small acreage and in which no unusual events occurred.

Sufficient information on all other fires will be provided to the Chief, Branch of Fire Management, Western Region who will recommend the appropriate level of review. This will be done within 30 days after the fire has been declared out.

Individual fires will be reviewed in accordance with NPS-18, Section III, Chapter 9 and classified into the following categories:

1. "Hotline" Review
2. Incident Management Team Closeout and Review
3. Park Level Review
4. Regional Level Review
5. National Level Review
6. Entrapment and/or Fire Shelter Deployment Review

"Hotline" Review

The purpose of the hotline review is to examine the progress of an on-going fire incident, regardless of size. The review will provide a confirmation of the decisions being made daily in the EFSA or determine where the decision process has been faulty and corrective actions are needed. The review is normally conducted by the Fire Management Officer in conjunction with the Incident Commander on the fire. These reviews require no special reporting. Documentation of these reviews should be included in the normal fire report narrative.

Incident Management Team (IMTI Closeout and Review

The agency administrator will conduct a close-out review with the IMT prior to their release from the fire incident. The purpose of this review is to ensure complete transition of the incident management back to the park and to evaluate the status of any incomplete fire business. A sample of closeout review topics is found in NPS-18, Section III, Chapter 9.

Park Level Review

The park level review should be conducted by the Superintendent or designated representative. The Superintendent will appoint other qualified persons to be a part of the review. The purpose of this review is to provide the Superintendent with information to recognize commendable actions and to take needed corrective actions.

Regional Level Review

A regional level review will generally be conducted for any fire that:

1. Crosses a park's boundary into another jurisdiction that does not have an interagency agreement.
2. Results in oversee media attention.
3. Involves a fatality, serious injury or significant property damage.
4. Results in controversy involving another agency.

The regional level review normally will be conducted at the park where the fire occurred. It will be convened by the Western Region, Chief, Branch of Fire Management, and attended by the Superintendent, Fire Management Officer, Incident Commander for the fire, and other individuals agreed upon by the Regional Director and Superintendent.

National Level Review

A national level review will generally be conducted for any fire that involves Service-wide or national issues, including:

1. Significant adverse media or political interest.
2. Multi-regional resource response.
3. A substantial loss of equipment or property.
4. Multiple, serious fire-related injuries.
5. Any other fire that the Director wants reviewed.

The national level review normally will be conducted at the park where the fire occurred. It will be convened by the Western Region, Chief, Branch of Fire Management, and attended by the Superintendent, Fire Management Officer, Incident Commander for the fire, and other individuals agreed upon by the Regional Director and Superintendent.

Sample questions and guidelines for final reports are found as Exhibits 2 and 3 of NPS-18, Section III, Chapter 9.

Entrapment and,/or Fire Shelter Deployment Review

Entrapments and fire shelter deployments will be reviewed in order to gather complete and accurate information to determine the reasons for the deployment. Corrective recommendations will be developed to minimize future situations which might lead to other shelter deployments. All entrapments and fire shelter deployments will be reported to the Western Region, Chief, Branch of Fire Management who will be responsible for developing the review team in cooperation with the Branch of Fire Management. The team leader will contact the agency administrator for reporting information. All entrapments and fire shelter deployments will be investigated as soon as possible after the deployment incident.

Specific directions for conducting an entrapment or shelter deployment review and guidelines for final reports are found as Exhibits 4 and 5 of NPS-18, Section III, Chapter 9.

The Fire Management Plan will be reviewed annually and revised as necessary to reflect a better understanding of the role fire can play in accomplishing land management objectives. The plan will be reviewed each year prior to January 15th. The plan will be reviewed by the Fire Management officer, park Resource Manager, Chief Ranger and the District Rangers from Stinson Beach, Marin Headlands and Ocean District. Plan changes will be attached as addendums.

The plan review and update will include a review of:

1. Currency with respect to area description and boundary changes.
2. Compliance with national, regional and park policies.
3. Any changes in fire management strategies.
4. Modifications to fire management units.
5. All fire management responsibilities.
6. All wildfire program elements.
7. The prescribed fire program.
8. Air quality and smoke management guidelines.
9. Fire research and monitoring.
10. Public safety.
11. Public information and education.
12. Archeological, cultural, and historic resources.
13. Consultation and coordination.
14. All appendices, including updating resource lists and phone numbers.

XVI. CONSULTATION AND COORDINATION

The original Fire Management Plan was first written in 1982 and revised in 1985 by Terri Thomas.

The following individuals and/or organizations were consulted in the preparation of this management plan.

Paul Reeberg	Resource Management Specialist, WR
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APPENDICES

APPENDIX A. REFERENCES CITED

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APPENDIX B. DEFINITIONS

Backing fire. A prescribed fire or wildfire burning into or against the wind or-down the slope without the aid of wind.

BEHAVE. A refinement of the Fire Behavior Prediction System that allows development of customized fuel models that can access the Rothermel fire spread equation (Burgan and Rothermel 1984).

Blackline. Preburning of fuels, either adjacent to a control line before igniting a prescribed fire or along a roadway or boundary as a deterrent to human-caused fires. Blacklining is usually done in heavy fuels adjacent to a control line during periods of low fire danger to reduce pressure on holding forces; blackline denotes a condition in which there is no unburned fine fuel remaining.

Burning index (BI). A relative number related to the contribution that fire behavior makes to the amount of effort needed to contain a fire in a specified fuel type. Doubling the BI indicates twice the effort will be required to contain a fire in that fuel type as was previously required providing all other parameters are held constant.

Cold trail. Method of controlling a partly-dead fire edge by careful inspection and feeling with the hand to detect any fire and extinguishing it by digging out every live spot and trenching any live edge.

Complex fire management program. A program involving prescribed burning, in addition to wildland fire suppression.

Density. The number of individuals, usually by species, per unit area.

Fire behavior. The response of fire to its environment of fuel, weather, and terrain including its ignition, spread, and development.

Fire effects. Physical, biological, and ecological impacts of fire on the environment.

Fire effects monitoring. A process that allows managers to evaluate whether environmental goals and objectives are being achieved and whether to adjust prescriptions to achieve a desired range of effects on the biotic and physical environment. Fire effects monitoring does not necessarily prove cause-and-effect associations. However, such monitoring will indicate if specific prescribed burn objectives were met and help management assess long-term change in these fire management areas.

Fire hazard. A fuel complex, defined by volume, type condition,

arrangement, and location, that determines the degree of ease of ignition and of resistance to control.

Fire intensity. A general term relating to the heat energy released in a fire.

Fire resistance. A botanical adaptation that results in a lower probability of being injured or killed by fire. (e.g., thick platy or corky bark, or buds protected by long needles).

Fire return interval. Length of time necessary for an area equal to the entire area of interest to burn; size of the area of interest must be clearly specified.

Fire monitoring. The systematic process of collecting and recording fire-related data, particularly with regards to fuels, topography, weather, fire behavior, fire effects, smoke, and fire location.

Fire weather. Weather conditions which influence fire ignition, behavior, and suppression.

Fireline. Generally, any cleared or treated strip used to control a fire's spread; more specifically, that portion of a control line from which flammable materials have been removed by scraping or digging to mineral soil.

Flame height. The average maximum vertical extension of flames at the leading edge of the fire front. Occasional flashes that rise above the general level of flames are not considered. This distance is less than the flame length if flames are tilted due to wind or slope.

Flame length. The distance between the flame tip and the midpoint of the flame depth at the base of the flame (generally the ground surface); an indicator of fire intensity.

Flammability. The relative ease with which a substance ignites and sustains combustion.

Fuel. The materials which are burned in a fire: duff litter, grass dead branch wood, snags, logs, stumps, weeds, brush, foliage, and to a limited degree, green trees.

Fuel break. Generally wide (10-1000 feet) strips of land on which native vegetation has been permanently modified so that fires burning into them can be more readily controlled. Some fuelbreaks contain firelines (e.g., roads, handlines) which can be quickly widened with hand tools or by burning out.

Fuel loading. Amount of dead fuel present on a particular site a given time; the percentage of fuel available for combustion changes

with the season.

Fuel model. Simulated fuel complex for which all fuel descriptors required for the solution of a mathematical rate of spread model have been specified.

Hazardous fuels. Fuels that, if ignited, could threaten park developments, human life and safety, natural resources, or carry fire across park boundaries.

Head fire. A fire front spreading or ignited to spread with the gradient (downwind or upslope).

Human-caused fire. Any fire caused directly of indirectly by person(s).

Mean Fire Interval. Arithmetic average of all fire intervals determined, in years in a designated area during a specified time period. Size of the area and the time period must be specified.

NFDRB. (National Fire Danger Rating System) Multiple index scheme designed to provide fire suppression and land management personnel with a systematic means of assessing various aspects of fire danger on a day-to-day basis.

NIFQB. (National Interagency Fire Qualification System) Fire management qualifications systems which describes for a particular large fire suppression organization the acceptable standards for experience, training, and physical fitness required for principal jobs within the system. NIFQS, when coupled with a large fire suppression organization, provides a complete system for fire management.

NIIMB. (National Interagency Incident Management System) Common command system designed to be used by any agency as a day-to-day operational procedure which can be expanded in scope to provide management for major single or multijurisdictional emergencies.

Natural fire. Any fire of natural origin (e.g., lightning, spontaneous combustion, volcanic activity).

Prescribed burning. The deliberate ignition of a fire in accordance with an established management plan to accomplish specific objectives under given prescriptions for weather and fuel conditions.

Prescribed fire. The skillful application of fire to natural fuels under conditions of weather, fuel moisture, soil moisture, etc., that will allow confinement of the fire to a predetermined area and at the same time will produce the intensity of heat and rate of spread required to meet certain overall objectives in the areas of silviculture, wildlife management, grazing, hazard fuel reduction,

etc. The overall objective of prescribed fire is to employ fire scientifically to realize maximum net benefits with minimum damage and acceptable cost.

Presuppression. Activities undertaken in advance of fire occurrence to help ensure more effective fire suppression; includes over-all planning, recruitment and training of fire personnel, procurement and maintenance of firefighting equipment and supplies, fuel treatment, and creating, maintaining, and improving a system of fuelbreaks, roads, water sources, and control lines.

Prevention. All activities concerned with minimizing the incidence of wildfires.

Rate of spread. Relative activity of a fire in extending its horizontal dimensions, expressed as rate of increase of the perimeter, rate of increase in area, or rate of advance of its head, depending on the intended use of the information; generally in chains or acres per hour for a specific period in the fire's history.

Rehabilitation. The activities necessary to repair damage or disturbance caused by wildfire or the fire suppression activity.

Smoke Management. Application of knowledge of fire behavior and meteorological processes to minimize degradation of air quality during prescribed fires.

Smokechaser. Person whose principal function is fire suppression.

Suppression. All actions intended to extinguish or limit the growth of fires, regardless of the strategies and tactics chosen.

Timelag. Time necessary, under specified conditions, for a fuel particle to lose approximately 63% of the difference between its initial moisture content and its equilibrium moisture content. Providing conditions remain unchanged, a fuel will reach 95% of its equilibrium moisture content after 4 timelag periods.

Urban/Wildland Interface. Line, area, or zone where structures and other human development meets or intermingles with undeveloped wildland or vegetative fuels.

Wet line. A line of water, or water and chemical retardant, sprayed along the ground, and which serves as a temporary control line from which to ignite or stop a low-intensity fire.

Wildfire. Any fire occurring on wildland that is not meeting management objectives and thus requires a suppression response.

WIMS. Weather Information Management System. A user-oriented interactive computer program which permits entry of fire weather

observations and fire weather -forecasts and which computes danger indices.

APPENDIX C. FIRE RELATED CALL-UP LIST

AGENCY/AREA	WORK TELEPHONE #
Boise Interagency Fire Center	
Doug Erskine	(208) 334-1055
Rick Gale	(208) 334-9541
Western Region, Branch of Fire Management	
Chris Cameron	744-3921
Tom Nichols	744-3878
North Zone	(916) 246-5354
Maria County Fire Department (Selfridge)	499-6717
Maria City Fire Department Uennings)	332-9120
Kentfield Fare Department (Bettencourt)	453-7464
Mill Valley Fire Department	388-4231
Sausalito Fire Department	289-4150
Stinson Beach FSre Department	868-0622
Inverness Volunteer Fire Department (Meszaros)	669-7151
Bolinas Fire Department (Hicks)	868-1566
Presidio Fare Department (Williams)	332-7139
Pacifica Fine Department (Stofau)	738-7361
California Department of Forestry, Sonoma	(707) 576-2275
California Department of Forestry, Belmont (Kirk)	345-1612
San Mateo County Fire Department	345-1612
San Mateo County Communication Center (Fire)	363-4961
City of San Bruno (Checchi)	877-8996
San Francisco Watershed (Stewart)	872-5931
Marin Municipal Water District (Badaracco)	924-4600, ext. 294
California State Parks	456-1286
Mount Tamalpais State Park (Pan Toll)	388-2070
Bay Area Air Quality Management District (Recording)	1-800-792-0787
Bay Area Air Quality Management District (Office)	771-6000
HOME TELEPHONE NUMBERS ARE ON FILE IN THE FIRE MANAGEMENT OFFICE	

APPENDIX C. FIRE RELATED CALL-UP LIST, Continued

AGENCY/AREA	WORK TELEPHONE #
Golden Gate National Recreation Area	
Fire Management Office	331-6374
U.S. Park Police (Emergency)	556-7940
U.S. Park Police (NON-Emergency)	556-7968
Superintendent (O'Neill)	556-2920
Chief Ranger (Soper)	556-4283
Information Specialist (Feinstein)	556-3103
District Rangers/Assistants:	
Stinson Beach (Danielsen/Eickenhorst)	556-0734
Marin Headlands (Suarez/Cheung)	331-1422
Ocean (Milestone/Prokop)	556-8371
Tamalpais (Fuller)	388-2596
Chief of Maintenance	556-3004
Point Reyes National Seashore	
Superintendent (Sensing)	663-8522
Chief Ranger (]Brock)	663-8525
North District (Case)	669-1071
South District (Wolfe)	663-8525
Chief of Maintenance (Williams)	663-8522

HOME TELEPHONE NUMBERS ARE ON FILE IN THE FIRE MANAGEMENT OFFICE

APPENDIX D. SPECIES LISTS

Plant Species found in the Grassland Community of GGNRA.	
Acaena californica	California acaena
Achillea millefolium	California yarrow
Agoseris heterophylla	annual agoseris
Agrostis diegoensis	leafy bent grass
Agrostis hallii	Hall's bent grass
Aira caryophylla	silver hairgrass
Allium dichlamydeum	coast onion
Amsinkia intermedia	fiddleneck
Arabis glabra	tower mustard
Avena fatua	wild oat
AVena barbata	slender wild oat
Brachypodium distachyon	purple false brome
Briza minor	little rattlesnake grass
Briza maxima	rattlesnake grass
Brodiaea terrestris	dwarf brodiaea
Bromus rubens	foxtail chess
Bromus carinatus	California brome
Bromus hordeaceus	soft chess
Bromus diandrus	ripgut brome
Calystegia occidentalis	morning glory
Calystegia subacaulis	morning glory
Camissonia ovata	sun-cup
Cardbus pycnocephalus	Italian thistle
Carex tumilicola	foothill sedge
Carex bolanderi	bolander's sedge
Carex densa	dense sedge
Carex brevicaulis	short-stemmed sedge
Centaurea melitensis	Napa thistle, tocalote
Chlorogalum pomeridianum	soap plant
Cirsium brevistylum	Indian thistle

Plant Species found in the Grassland Community of GGNRA.	
Cirsium vulgare	bull thistle
Cirsium quecetorum	brownie thistle
Conium maculatum	poison hemlock
Convolvulus arvensis	field bindweed
Cynosurus echinatus	dogtail grass
Dactylis glomerata	orchard grass
Danthonia californica	California oat grass
Danthonia pilosa	purple-awned wallaby gras
Daucus pusillus	rattlesnake weed
Dichelostemma pulchellum	blue dicks
Dichondra donneliana	dichondra
Dudleya farinosa	bluff lettuce
Elymus glaucus	blue wild rye
Elysitanion hansenii	Hansen's squirreltail
Erigeron glaucus	seaside daisy
Erigeron foliosus	leafy daisy
Eriogonum latifolium	coast buckwheat
Ex-odium cicutarium	red-stem filaree
Erodium botrys	broad-leaf filaree
Erodium brachycarpum	filaree
Escholtzia californica	California poppy
Festuca rubra	red fescue
Festuca arundinacea	tall fescue
Festuca idahoensis	Idaho or blue fescue
Festuca californica	California fescue
Filago gallica	narrow-leaved filago
Foeniculum vulgare	sweet fennel
Fragaria vesca californica	California strawberry
Gastridium ventricosum	nit grass
Genista monspessulanus	French broom
Geranium mo11e	crane's bill geranium

Plant Species found in the Grassland Community of GGNRA.	
Geranium dissectum	cut-leaved geranium
Geranium retrorsum	New Zealand geranium
Gnaphalium palustre	lowland cudweed
Gnaphalium luteo-album	everlasting, cudweed
Grindelia hirsutula	hirsute grindelia
Gutierrezia californica	matchweed, snakeweed
Heterotheca bolanderi	golden aster
Hirschfeldia incana	summer mustard
Holcus lanatus	velvet grass
Hordeum murinum leporinum	farmer's foxtail
Hordeum brachyantherum	meadow barley
Horkelia californica	California horkelia
Hypocheris radicata	hairy cat's ear
Hypocheris glabra	smooth cat's ear
Hystrix californica	California bottle grass
Iris douglasiana major	Marin iris
Iris douglasiana	Douglas iris
Iris longipetala	coast iris
Juncus patens	spreading or common rush
Juncus effusus brunneus	bog rush
Juncus occidentalis	western rush
Koeleria pyramidata	june grass
Lactuca saligna	*willow* lettuce
Lasthenia californica	goldfields
Linum angustifolium	flax
Lolium perenne	perennial rye grass
Lolium multiflorum	italian rye grass
Lomatium dasycarpum	lace parsnip
Lotus micranthus	small-flowered trefoil
Lotus subpinnatus	Chilean trefoil
Lupinus propinquus	blue bush lupine

Plant Species found in the Grassland Community of GGNRA.	
Lupinus nanus	*sky* lupine
Lupinus variicolor	varied lupine
Lupinus albifrons	silver bush lupine
Lupinus formosus	summer lupine
Lupinus bicolor	annual lupine
Lupinus arboreus	yellow bush lupine
Luzula comosa congesta	wood rush
Nadia sativa	coastal tarweed
Nadia gracilis	slender tarweed
Nadia anomala	tarweed
Nadia elegans	common madia
Nadia exigua	small tarweed
Nadia capitata	headland tarweed
Mahonia pinnata	coast barberry
Malva nicaeensis	bull mallow
Marah fabaceus	manroot, wild cucumber
Medicago polymorpha	bur clover
Melica torreyana	Torrey's melica
Melica californica	California melic
Melica imperfecta	small-flowered melica
Melica geyeri	Geyer onion grass
Navarretia squarrosa	skunkweed
oxalis albicans pilosa	hairy wood sorrel
Paronchyia franciscana	California whitlow-wort
Perideridia kelloggii	Kellogg's yampah
Phacelia malvaefolia	stinging phacelia
Phacelia californica	California phacelia
Phalaris aquatica	harding grass
Picris echioides	bristly ox-tongue
Plantago erecta	California plantain
Plant ago lanceolata	English *plantain*

Plant Species found in the Grassland Community of GGNRA.	
Poa scabrella	pine bluegrass
Poa pratensis	Kentucky bluegrass
Poa unilateris	San Francisco bluegrass
Poa annua	annual bluegrass
Poa compressa	Canada bluegrass
Polycarpon tetraphyllum	four-leaved polycarp
Polygonum paronychia	dune knotweed
Polygonum arenastrum	dooryard knotweed
Pteridium aquilinum	bracken fern
Pterostegia drymarioides	pterestegia
Ranunculus californica	California buttercup
Raphanus sativus	wild radish
Rumex conglomeratus	green dock
Rumex acetosella	sheep sorrel
Rumex occidentalis procerus	dock
.Rumex crispus	curly dock
Sanguisorba minor	burnet
Sanicula bipinnatifida	purple sanicle
Scleroderma flavidum	earth ball
Sherardia arvensis	field madder
Sidalcea malvaeflora	checkerbloom
Silene gallica	windmill pink
Silybum marianum	milk thistle
Sisyrinchium bellum	blue-eyed grass
Sitanion jubatum	California oatgrass
Solidago californica	California goldenrod
Sonchus aspen	prickly sow thistle
Sonchus oleraceous	*sow* thistle
Stachys ajugoides	hedge nettle
Stellaria media	chickweed
Stellaria littoralis	shore chickweed

Plant Species found in the Grassland Community of GGNRA.	
Stephanomeria virgata	tall stephanomeria
Stipa lepida	foothill needle grass
Stipa cernua	needle grass
Stipa pulchra	purple needle grass
Triteleia laxa	Ithuriel's spear
Vicia sativa nigra	smaller common vetch
Vicia sativa	common vetch
Vicia americana	American vetch
Vicia bengalensis	vetch
Vulpia bromoides	squirrel-tail fescue
Wyethia angustifolia	narrow-leaf mule's ears

Plant Species found in the Coastal Scrub Community of GGNRA.	
Anagalis arvensis	scarlet pimpernel
Anaphalis margaretacea	pearly everlasting
Angelica hendersonii	coast angelica
Artemisia douglasii	California mugwort
Artemisia californica	California sagebrush
Astragalus franciscanus	San Francisco rattle weed
Avena barbata	slender wild oat
Baccharis pilularis	coyote brush
Barbarea orthoceras	wintercress
Bromus hordeaceus	soft chess
Bromus diandrus	ripgut brome
Calystegia subacaulis	morning glory
Cardamine oligosperma	bitter-cress
Carex brevicaulis	short-stemmed sedge
Castilleja franciscana	Franciscan paintbrush
Castilleja wightii	Wight's indian paintbrush
Ceanothus thrysiflorus	blueblossom
Chenopodium californicum	California goosefoot
Chlorogalum pomeridianum	soap plant
Cirsium brevistylum	Indian thistle
Cirsium vulgare	bull thistle
Claytonia perfoliata	miner's lettuce
Conyza canadensis	horseweed
Corylus cornuta californica	California hazel
Cotoneaster pannosa	cotoneaster
Danthonia californica	California oat grass
Elymus glaucus	blue wild rye
Epilobium ciliatum watsonii	San Francisco willow herb
Erechtites minima	Australian fireweed
Erechtites arguta	New Zealand fireweed

Plant Species found in the Coastal Scrub Community of GGNRA.	
Eriophyllum staechadifolium	lizard tail
Eriophyllum confertiflorum	yellow yarrow
Festuca californica	California fescue
Fragaria vesca californica	California strawberry
Galium spurium echinospermum	bedstraw, cleavers
Galium aparine	bedstraw, cleavers
Galium californicum	California bedstraw
lium nuttallii ovalifolium aa	bedstraw, cleavers
Genista monspessulanus	French broom
Gnaphalium ramosissimum	pink everlasting
Gnaphalium californica	green everlasting
Heracleum lanatum	*cow* parsnip
Heteromeles arbutifolia	toyon, Christmas berry
Hirschfeldia incana	summer mustard
Holcus lanatus	velvet grass
Holodiscus discolor	ocean spray
Horkelia californica	California horkelia
Iris douglasiana	Douglas iris
Leucanthemum vulgare	ox-eye daisy
Ligusticum apiifolium	lovage
Lobularia maritima	sweet alyssum
Lolium multiflorum	italian rye grass
Lonicera hispidula	California honeysuckle
Lotus micranthus	small-flowered trefoil
Lotus subpinnatus	Chilean trefoil
Lupinus propinguus	blue bush lupine
Lupinus arboreus	yellow bush lupine
Marah fabaceus	manroot, wild cucumber
Marah oreganus	manroot, wild cucumber
Mimulus aurantiacus	sticky monkey flower
Monardella villosa	coyote mint

Plant Species found in the Coastal Scrub Community of GGNRA.	
oemleria cerasiformis	*oso* berry
Oxalis albicans pilosa	hairy wood sorrel
Plantago lanceolata	English plantain
Polystichum munitum	western sword fern
Potentilla glandulosa	sticky cinquefoil
Pteridium aquilinum	bracken fern
Pterostegia drymarioides	pterestegia
Rhamnus californica	coffeeberry
Rhamnus crocea	redberry
Ribes californica	California gooseberry
Ribes menziesii	gooseberry
Rosa gymnocarpa	wood rose
Rubus parviflorus velutinus	thimbleberry
Rubus discolor	Himalaya berry
Rubus ursinus	California blackberry
Sambucus callicarpa	red elder berry
Sanicula crassicaulis	pacific sanicle
Satureja douglasii	yerba buena
Scrophularia californica	California bee plant
Selaginella bigelovii	moss fern
Selaginella wallacei	moss fern
Solanum umbelliferum	blue witch
Solanum americanum	small-flowered nightshade
Solanum douglasii	Douglas' nightshade
Stachys ajugoides	hedge nettle
Stipa lepida	foothill needle grass
Stipa pulchra	purple needle grass
Symphorocarpos rivularis	snowberry
Toxicodendron diversilobum	poison oak
Vulpia megalura	foxtail fescue
Vulpia bromoides	squirrel-tail fescue

Plant Species found in the Coastal Scrub Community of GGNRA.	
Vulpia octoflora	slender fescue
Zigadenus fremontii	star lily, zygadene

Plant Species found in the Chaparral Community of GGNRA.	
Adenostoma fasiculatum	chamise
Arctostaphylos canescens	hoary manzanita
Arctostaphylos cushingiana	manzanita
Arctostaphylos sensitivus	shatterberry
Arctostaphylos glandulosa	eastwood manzanita
Arctostaphylos virgata	Marin manzanita
Castanopsis chrysophylla minor	chinquapin
Ceanothus foloiosus	indigo brush
Ceanothus masonii	mason's California lilac
Ceanothus ramulosus	Blue buck-brush
Ceanothus sorediatus	jim brush
Ceanothus gloriosus exaltatus	glory mat
Cercocarpus betuloides	mountain mahogany
Cryptantha muricata	nievitas
Cryptantha torreyana pumila	nievitas -
Dendromecon rigida	tree poppy
Eriodictyon californicum	yerba santa
Garrya elliptica	silk tassel bush
Helianthemum scoparium vulgare	broom-rose
Heteromeles arbutifolia	toyon
Hypericum concinnum	gold wire
Lepechina calycina	pitcher sage
Lotus scoparius	deerweed
Lupinus douglasii fallax	Tamalpais lupine
Pickeringia montana	chaparral pea
Quercus wislizeni frutescens	chaparral oak
vaccinium ovatum	huckleberry
Xerophyllum tenax	squaw grass
Zigadenus fremontii	star lily

Plant Species found on Serpentine in GGNRA.	
Allium falcifolium	serpentine onion
Arctostaphylos montana	Tamalpais manzanita
Arenaria douglasii	arenaria
Aspidotis densa	serpentine fern
Calamagrostis purpurascens ophidtidus	reedgrass
Claytonia spathulata	claytonia
Calochortus umbellatus	Oakland star-tulip
Calystegia malacophyllus	morning glory
Ceanothus jepsonii	musk bush
Cupressus sargentii	sargent cypress
Epilobium minutum	*willow* herb
Erigeron inornatus angustatus	pine erigeron
Escholtzia californica	California poppy
Hesperolinon congestum	Marin dwarf flax
Mimulus glareosus	monkey flower
Monardella neglecta	western pennyroyal
Pellaea mucronata	birdfoot fern
Quercus durata	leather oak
Sanicula tuberosa	turkey pea
Stipa pulchra	purple needle grass
Streptanthus glandulosus pulchellus	Tamalpais jewel flower

Plant Species found in the Mixed Evergreen Forest Community of GGNRA.	
Acer macrophyllum	big leaf maple
Aralia californica	elk clover
Arbutus menziesii	madrone
Arctostaphylos virgata	marin manzanita
Castanopsis chrysolephylla	chinquapin
Castilleja latifolia rubra	indian paintbrush
Ceanothus thrysiflorus	blueblossom
Circaea pacifica	enchanter's nightshade
Corylus cornuta californica	California hazel
Cynoglossum grande	hound's tongue
Delphinium nudicale	red larkspur
Galium triflorum	bedstraw, cleavers
Gaultheria shallon	salal
Lithocarpus densiflorus	tan-oak
Madia madioides	tarweed
Pedicularis densiflora	indian warrior
Petasites palmatus	western colt's foot
Polygala californica	milkwort
Polypodium californicum	California polypody
Pseudotsuga menziesii	douglas fir
Pteridium aquilinum	bracken fern
Quercus agrifolia	coast live oak
Quercus chrysolepis	canyon live oak
Quercus garrayana	garry oak
Quercus kelloggi	California black oak
Ramilina menziesii	fruticose lichen
Rhamnus californica	coffeeberry
Rhododendron occidentale	Western azalea
Romanzoffia californica	mist maiden
Rosa gymnocarpa	wood rose
Sanicula lacinata	sanicle

Plant Species found in the Mixed Evergreen Forest Community of GGNRA.	
Satureja douglasii	yerba buena
Selaginella wallacei	moss fern
Torreya californica	California nutmeg
Toxicodendron diversilobum	poison oak
Trientalis latifolia	star flower
Umbellularia californica	California bay
Yaccinum ovatum	huckleberry
Whipplea modesta	modesty
Woodwardia fimbriata	western chain fern

Plant Species found in the Oak Woodland Community of GGNRA.	
Acer macrophyllum	big leaf maple
Aesculus californicus	California buckeye
Athyrium felix-femina	common lady fern
Arbutus menziesii	madrone
Artemisia californica	California sagebrush
Baccharis pilularis	coyote brush
Ceanothus thrysiflorus	blueblossom
Corylus cornuta californica	California hazel
Cynoglossum grande	hound's tongue
Dryopteris arguta	wood fern
Festuca califarnica	California fescue
Galium aparine	bedstraw, cleavers
Galium californicum	California bedstraw
Gaultheria shallon	salal
Heteromeles arbutifolia	toyon, christmas berry
Holodiscus discolor	ocean spray
Iris douglasiana major	Marin iris
iris douglasiana	Douglas iris
Lonicera hispidula	California honeysuckle
Marah oreganus	manroot, wild cucumber
Mimulus aurantiacus	sticky monkey flower
Myrica californica	California wax-myrtle
Pedicularis densiflora	indian warrior
Polypodium californicum	California polypody
Polystichum munitum	western sword fern
Pteridium aquilinum	bracken fern
Quercus agrifolia	coast live oak
Quercus chrysolepis	canyon live oak
Quercus kelloggii	California black oak
Quercus lobata	valley oak
Ramilina menziesii	fruticose lichen

Plant Species found in the Oak Woodland Community of GGNRA.	
Rhamnus californica	coffeeberry
Ribes califox-nica	California gooseberry
Romanzoffia californica	mist maiden
Rosa gymnocarpa	wood rose
Rubus parviflorus velutinus	thimbleberry
Sambucus callicarpa	red elder berry
Sanicula lacinata	sanicle
Satureja douglasii	yerba buena
Solanum americanum	small-flowered nightshade
Stachys ajugoides	hedge nettle
Symphorocarpos rivularis	snowberry
Tellima grandiflora	fringe-cups
Toxicodendron diversilobum	poison oak
Umbe11ularia californica	California bay
Urtica urens	stinging nettle
Vicia sativa nigra	smaller common vetch
Vicia sativa	common vetch
Woodwardia fimbriata	western chain fern

Plant Species found in the Redwood Forest Community of GGNRA.	
Adenocaulon bicolor	trail plant
Acer macrophyllum	big leaf maple
Anemone quinquefolia grayi	windflower
Athyrium felix-femina	common lady fern
Arbutus menziesii	madrone
Asarum caudatum	wild ginger
Carex globosa	round-fruited sedge
Ceanothus thrysiflorus	blueblossom
Clintonia andrewsiana	red clintonia
Corylus cornuta californica	California hazel
Disporum hookeri	fairy bells
Disporum smithii	fairy bells
Euonymus occidentalis	Western burning bush
Galium californicum	California bedstraw
Gaultheria shallon	salal
Goodyera oblongifolia	rattlesnake plantain
Heteromeles arbutifolia	toyon, christmas berry
Hierochloe occidentalis	California vanilla grass
Hystrix californica	California bottle grass
Lathyrus torreyi	redwood pea
Lithocarpus densiflorus	tan-oak
Marah oreganus	manroot, wild cucumber
Myrica californica	California wax-myrtle
Osmorhiza chilensis	sweet ciceley
Oxalis oregana	redwood sorrel
Parmotrema chinense	foliose lichen
Polygala californica	milkwort
Polystichum munitum	western sword fern
Pseudotsuga menziesii	douglas fir
Pteridium aquilinum	bracken fern
Quercus agrifolia	coast live oak

Plant Species found in the Redwood Forest Community of GGNRA.	
Ramilina menziesii	fruticose lichen
Rhododendron occidentale	Western azalea
Rosa gymnocarpa	wood rose
Rubus parviflorus velutinus	thimbleberry
Scoliopus bigelovii	fetid adder's toungue
Selaginella wallacei	*moss* fern
sequoia sempervirens	coast redwood
Smilacina sessilifolia	*slim* solomon
Torreya californica	California nutmeg
Toxicodendron diversilobum	poison oak
Trillium ovatum	trillium, wake robin
Triteleia laxa	Ithuriel's spear
Trientalis latifolia	star flower
ombellularia californica	California bay
Vaccinum ovatum	huckleberry
Viola sempervirens	redwood violet

APPENDIX E. PRESUPPRESSION INVENTORY

Slip-on Units

1. One slip-on unit (100 gallon mounted on a 4 X 4 truck) located in the Ocean District.

2. One slip-on unit (100 gallon mounted on a 4 X 4 truck) located in the Marin Headlands District.

3. One slip-on unit (100 gallon mounted on a 4 X 4 truck) located in the Stinson Beach District.

Fire Caches

1. 10 person fire cache located in the Ocean District.

2. 10 person fire cache located in the Marin Headlands District.

3. 10 person fire cache located in the Stinson Beach District.

4. Western Region Fire Cache includes equipment for Western Region Fire Crews, including radios, chainsaw kits, and personal protective equipment for National Park Service fire personnel assigned to regional fire crews.

APPENDIX F. PRESCRIPTION INFORMATION

Fuel model descriptions are found in Deeming et al. (1978), Albini (1976) and Anderson (1982). Refinement of prescriptions will occur as prescribed burn data is compiled.

GRASSLAND/COASTAL SCRUB

The appropriate fuel model for the grassland/coastal scrub community is Fuel Model 1. Where more than one-third of the cover is coastal scrub, Fuel Model 2 is used. Where more than two-thirds of the cover is coastal scrub, Fuel Model 5 is used. The following fire prescription is used in the grassland/ coastal scrub community.

Season	Fall
Temperature	45-70°F
Relative Humidity	35-80%
Wind	0-10 mph
1-hour Timelag Fuels	6-10%
10-hour-Timelag Fuels	10-20%
Live fuel moisture	80-120%
Burning Index	20-40

BROADLEAF EVERGREEN FOREST

Fire Behavior Fuel Model 2 is appropriate for this fuel type.

Season	Fall
Temperature	60-70°F
Relative Humidity	35-80%
Wind Speed	0-10 mph
1-Hour Fuel Moisture	6-10%
10-Hour Fuel Moisture	10-20%
Burning Index	10-30

CHAPARRAL

Chaparral fuel models are dependent upon the age class of the stand: (1) Young green stands with no dead wood are considered to be characteristic of Fire Behavior Model 5; (2) Intermediate stands of chaparral are represented by Fire Behavior Fuel Model 6; (3) Mature chaparral is represented by Fire Behavior Fuel Model 4. The following prescription is used in Chaparral at Pinnacles National Monument and will be used and refined by Golden Gate National Recreation Area.

Season	Late Summer or Fall
Temperature	64-84°F
Relative Humidity	35-80%
Wind speed	0-10 mph
1 hr. fuel moisture	4-7%
10 hr. fuel moisture	6-11%
100 hr. fuel moisture	12-15%
Live fuel moisture	80-120%
Burning index	32-58

OLD GROWTH REDWOOD FOREST

Fire Behavior Fuel Model 8 is appropriate for this fuel type. The following prescription will be used in old growth redwood forest:

Season	Fall
Temperature	55-70°F
Relative Humidity	40-75%
Wind Speed	0-10 mph
1-Hour Timelag Fuels	8-11%
10-Hour Timelag Fuels	11-14%
Burning Index	10-20

SECOND GROWTH REDWOOD AND DOUGLAS FIR

Fire Behavior Fuel Model 8 is used in this community when the fire is being carried by a compact litter layer and occasional "jackpot" fuels. In areas where fire is carried by dead surface and ground fuel with large amounts of ladder fuels the use of Fire Behavior Fuel Model 10 is most appropriate. This is characteristic of logged areas on Bolinas Ridge. Fuel Model 9 will be used when a large component of hardwood litter will carry the fire. The following prescription will be used in the Douglas fir communities. Douglas fir/redwood communities is burned at the conservative end of the prescription with lower temperatures and higher relative humidities.

Season	Fall
Temperature	60-80°F
Relative Humidity	35-75%
Wind Speed	0-10 mph
1-Hour Timelag Fuels	5-9%
l0-Hour Timelag Fuels	8-15%
Burning Index	10-20

EUCALYPTUS/OTHER EXOTICS

Current fuel models do not accurately predict fire behavior in Golden Gate National Recreation Area eucalyptus. Australia's fuel model for eucalyptus does not address initial fuel loadings as high as those found within Golden Gate National Recreation Area (McArthur 1967). The BEHAVE programming of fuel models not represented in the FIRE BEHAVIOR or NFDRS systems may show future potential. Prescriptions for other exotic species will be developed as needed.

Season	winter or spring
Temperature	60-70*F
Relative Humidity	40-75%
Windspeed	0-10 mph
1-Hour Fuel Moisture	6-10%
10-Hour Fuel Moisture	10-20%
Burning Index	10-30

APPENDIX G. ESCAPED FIRE SITUATION ANALYSIS

Western Region - Golden Gate National Recreation Area

PRE-ATTACK EFSA

The EFSA is a decision process that employs a systematic and reasonable approach to determine the most appropriate suppression strategy for a particular situation. Reasonable suppression alternatives are identified, analyzed and evaluated, and are consistent with the expected probability of success or failure. The agency administrator (Superintendent) shall approve the EFSA and any revisions. Evaluation criteria include anticipated suppression costs, resource impacts, and environmental, social and political considerations. The evaluation of alternatives must clearly identify the point of which the failure of the alternative is imminent. This becomes the triggering mechanism for reevaluation of the EFSA.

APPENDIX G. ESCAPED FIRE SITUATION ANALYSIS, (cont.)

EVALUATION CRITERIA

Economic:	Power Line Integrity - Utilities Urban Interface Concessioner Facilities Road and Trail Network Government Facilities
Environmental:	Watershed Influences Threatened and Endangered Species Soil Protection Audubon Canyon Muir Woods
Social:	Airshed Quality In-Holder Developments General Outdoor Recreation
Other:	Archeological and Cultural Resources Neighboring Lands

ALTERNATIVES

	A	B	C	D
GENERAL PLAN OF CONTROL (STRATEGIC)	Full Fire Control 10 a.m. Control of all fires (1st burning period)	Confine within first topographical break, within 2nd burning period. Fire management using modified suppression.	Confine within major topographical break within 3rd burning. Fire management using modified suppression.	Confine to Golden Gate National Recreation Area lands. Fire management using modified suppression.
SPECIFIC PLAN OF CONTROL (TACTICAL)	Direct Attack of Perimeter	Direct/Indirect Attack of Perimeter	Indirect Attack of Perimeter	Indirect Attack of Perimeter
PROBABILITY OF SUCCESS	97%	90%	75%	50%
ESTIMATED CONTROL TIME	< 12 hours	24 hours	48 hours	> 48 hours

APPENDIX G. ESCAPED FIRE SITUATION ANALYSIS, (cont.)

EFFECTS

	A	**B**	**C**		**D**
SIZE (Predicted final size in acres)	10	100	1,000		10,000
MARKET ELEMENTS					
Timber	N/C	N/C	N/C		N/C
Improvements	-	-	---		---
Recreation	N/C	+ +	--		---
Wilderness	N/A	N/A	N/A		N/A
Wildlife	+	+	+++		++++
Fish	N/A	N/A	N/A		N/A
Water	N/C	-	---		--
Forage	+	+	+		++
SUM OF NET VALUE CHANGE	+1	+2	-5	-3 ,	
NON-MARKET ELEMENTS					
Air	-	--	---		---
Visual	N/C	N/C	-		--
Fuels	N/C	+	+ +		+ + +
Threatened & Endangered Species	N/C	-	-		-
SUM OF NET VALUE CHANGE	-1	-2	-3		-3
SOCIAL ELEMENTS					
Firefighter Safety	-	--	--		--
Employment	N/C	N/C	N/C		+
Public Concern	+ +	+	-		---
Public Safety	**++**	**+**	**-**		**- -**
Cultural	+ + +	+	-		--
Other	+	+	-		-
SUM OF NET VALUE CHANGE	+7	+2	-6		-11
SUPPRESSION COSTS	$ 2,000/acre	$ 1,000/acre	$ 225/acre		$ 225/acre
COST PLUS NET VALUE CHANGE	N/A	N/A	N/A		N/A

APPENDIX G. ESCAPED FIRE SITUATION ANALYSIS. (cont.)

EVALUATION

CRITERIA	**A**	**B**	**C**	**D**
ECONOMIC	(2) Small impact. All out suppression effort. Minimum to structures and developments.	(1) Possible impact to power facilities and/or threat to structures. Possible litigation for escapes.	(1) Direct threats to structures and human values. Possible litigation for escapes.	
ENVIRONMENTAL	(1) Little direct impact from fire. Full rehabilitation required.	(1) Airshed impacted for short time. Some soil loss. Mosaic effect to fire/unburned islands. Fuel reduction. Full rehabilitation required.	(1) Airshed impacts for two days. Some watershed damage. Fuel reduction of fire fuels, creates fires in large sizes including snags. Extensive rehabilitation required.	(0) Airshed impact for duration of incident considerable. Watershed damage. Fuel reduction of fire fuels offset by increase in large fuels. Rehabilitation plan required for extensive work.
SOCIAL	(2) Formal contracts with contractors to be complied with. Public concerns satisfied. Cultural resources protected.	(2) Unified Command in ICS. Partial closure of NRA where affected. Bulldozers restricted.	(1) Unified Command in ICS. Resource advisor from NPS in plans. RM Rangers on line-divisions. Closure of NRA where affected. Cultural resource protected. Bulldozers restricted.	
OTHER	(1)	(1) Press release at control. Public information function mobilized. Other agencies fully informed.	(1)	(i)

KEY: 0 = Does not meet criteria
1 = Partially meets criteria

2 = Fully meets criteria

APPENDIX G. ESCAPED FIRE SITUATION ANALYSIS, (cont)

SELECTED ALTERNATIVE

Selected Alternative:

A then B then C then D

Justification:

- Human values at risk from modified suppression actions.
- Potential watershed damage from high intensity wildfire.
- Rehabilitation will be extensive on large fires.
- Unified command with CDF-Marin County Fire Department-NPS for management of the incident.
- Full suppression of wildfire is the order.
- Direct attack, going indirect when necessary for firefighter safety. Natural and human boundaries are to be used when possible.
- Constraints are placed on bulldozers. They are permitted only by specific Agency approval.
- Rehabilitation will be completed before personnel or equipment are released from fire.
- Freshwater drops are used before retardant.
- Fugative retardant to be used, not non-fugative retardant.
- Saltwater drops are used with approval of NPS representative.

Public Information Direction:

- Refer to Fire Management Plan for specific direction.
- Fire Management Officer will designate Information Officer.
- Cooperation with Marin County emergency communication center and CDF.

APPENDIX H. PRESCRIBED FIRE QUALIFICATIONS

1. PRESCRIBED FIRE MANAGER

Duties

Responsible for the development of burning prescriptions and prescribed burning plans in addition to those duties outlined in the Prescribed Fire Qualification Guide.

Training

RX-93 Advanced Fire Effects
RX-95 Smoke Management Techniques
RX-97 Prescribed Fire Manager

Experience

Must complete two trainee assignments and be qualified as a Burn Boss.

Physical Fitness

Achieve a Step Test (or alternative running test) fitness score of 40 annually and complete a physical fitness examination every three years.

2. PRESCRIBED BURN BOSS

Duties

Responsible for the implementation of burning prescriptions and prescribed burning plans in addition to those duties outlined in the Prescribed Fire Oualification Guide.

Training

RX-90 Prescribed Fire for Burn Bosses

Experience

Must complete two certification burns. Must also be qualified as a Fire Behavior and Weather Specialist II, Ignition Specialist, and Incident Commander-Single Resource.

Physical Fitness

Achieve Step Test (or alternative running test) fitness score of 45 annually and complete a physical fitness examination every three years.

3. IGNITION SPECIALIST

Duties

Responsible for all duties as assigned by the Prescribed Burning Boss which may include acting as Holding Boss or Prescribed Fire Monitor depending upon personnel available and complexity of burn.

Training

S-215 Firing Equipment and Methods
RX-96 Ignition Specialist

Experience

Must complete two trainee assignments and be qualified as a Holding Specialist.

Physical Fitness

Achieve Step Test (or alternate running test) fitness score of 45 annually and complete a physical fitness examination every 3 years.

APPENDIX I. PRE-ATTACK PLANNING CHECKLIST

COMMAND	➨	OPERATIONS	➨
Pre-attack EFSA (if appropriate)		Helispot, helibase locations	
Pre-positioning needs		Flight routes, restrictions	
Draft delegation of authority		Water sources	
Management constraints		Control line locations	
Interagency agreements		Natural barriers	
Evacuation procedures		Safety zones	
Structural protection needs		Staging area Locations	
Closure procedures			
LOGISTICS	➨	**PLANNING**	➨
ICP base ca Locations		Park base map	
Roads, trails		Topographic maps	
Utilities		Infrared imagery	
Medical facilities		Vegetation/fuel maps	
Stores restaurants gas stations		Hazard Locations (ground and aerial)	
Transportation resources location		Archeological/Cultural base map	
Rental equipment sources (by type)		Endangered species critical habitats	
Construction contractors		Sensitive plant populations	
Sanitary facilities		Special visitor use area	
Police, fire departments		Land status	
Communications (radio, telephone)			
Sanitary landfills			
Portable water sources			
Maintenance facilities			

APPENDIX J. REHABILITATION GUIDELINES

The following rehabilitation measures were taken from the Western Region Wildland Fire Resource Advisors Task Book (draft 1991).

Natural Resources Rehabilitation Measures

1. Reseeding

All reseeding is prohibited unless activity occurs within a developed zone specified in the park General Management Plan or along major, paved road corridors in the park. Reseeding will be done only for safety purposes (mitigation of landslide threats to human development). Reseeding specifications for rehabilitation purposes must be specifically approved in the park's current Natural Resources Management Plan.

2. Revegetation/Landscaping

All revegetation and/or landscaping is prohibited unless activity occurs within a developed zone specified in the park General Management Plan. A separate revegetation and/or landscaping plan must be included as an attachment to the NPS Western Region Rehabilitation Plan and Accomplishment Report and must be developed in accordance with the Western Region Revegetation Rehabilitation Handbook (Draft, 1991).

3. Mulch

Mulch is to be used only in conjunction with an approved reseeding program. Only native tree bark or rice straw is permitted for use, not to exceed 1500 lbs./acre.

4. Soil Netting

Biodegradable soil netting is permitted with prior submittal and approval of specifications and manufacturer information.

5. Check Dams

Only log, loose rock or straw bale check dams will be constructed with the use of emergency rehabilitation funding. The use of logs or rocks in check dam construction must be specifically justified and approved in the NPS-Western Region Rehabilitation Plan. A detailed set of specifications, specifying frequency and procedures for installing check dams, is maintained in the office of the Regional Forester, Western Regional Office. Generally speaking, check dams will be installed only on highly sensitive soils on intensively burned areas in park developed zones approved specifically in the park General Management Plan. The primary objective for the installation of check dams is to retrap

sediment that could be mobilized thus causing landslides and flash floods in developed zones.

6. Water Course Stabilization

only first order drainages will be rehabilitated using emergency rehabilitation funds. In these locations all fill that was pushed into the channel will be excavated out and placed back onto the cut slopes from which it came. The channel will be reshaped to match the pre-existing stream side sloped and channel grade. Nearby natural duff and litter will be scattered onto the side slopes to help reduce surface erosion. All other debris placed into stream courses as a result of suppression actions will be removed, including felled trees. See N5 for check dam information and the following guidelines pertaining to removal of stream debris.

7. Fence

A detailed set of approved fence specifications is kept on file in the office of the Regional Forester, Western Region. All fencing proposed within the NPS-Western Region Fire Rehabilitation Plan must be specifically approved by the Regional Grazing Management Specialist. Generally speaking, only temporary fence built to the minimum specification required to restrict the movement of domestic livestock or feral animals for a period not to exceed one year will be constructed with the use of FIREPRO rehabilitation funds. These funds may be supplemented with ONPS funds to restore fence to original specification and condition. Electrical fence may be constructed to restrict fence over the short term in frontcountry areas. Aesthetic or drift fencing will not be replaced with emergency rehabilitation funding.

8. Trail Stabilization

Trails will be restored and/or stabilized only to a specification which will allow for safe use by park visitors. In some cases this level of specification may not completely restore a trail to its pre-fire standard or satisfy all the requirements for resource protection in and along the trail. The restoration of any park access route to a standard above its pre-fire standard is strictly prohibited.

Appropriate trail rehabilitation measures which may be funded with emergency rehabilitation funds include the following:

- Obliteration of newly constructed fire access areas after the fire is controlled;

- Clearance of downed timber or other obstructions which may create post-fire safety hazards;

For safety reasons, restoration of the grade and shape of water bars damaged or removed during fire. The following minimum standards will be adhered to when installing new or replacing water bars:

FIRELINE GRADIENT (perpendicular to slope)	**SPACING OF WATER BARS**	
	ERODIBILITY OF SOIL ON FIRELINE	
	MEDIUM (M)	**HIGH (H)**
Less than 15%	200'	150'
15 to 30%	100'	75'
30 to 45%	65'	50'
Steeper than 45%	30'	25'

* **WATER BARS SHALL BE PUT IN BY HAND (NO BULLDOZERS).**

* **THESE ARE MINIMUM STANDARDS AND ARE NOT INTENDED TO RESTRICT THE IMPLEMENTATION OF MORE WATER BARS IF THE NEED IS JUSTIFIED AND APPROVED IN THIS PLAN-**

General interpretive or location signs which were displayed along trail routes and were destroyed or damaged by fire will not be replaced with emergency rehabilitation funds. Signs which pertain to an emergency trail closure directly related to the fire, or safety information related to continuing fire activity or deteriorating trail conditions related to suppression activities may be purchased and constructed with emergency rehabilitation funds.

9. Road,/Fireline Obliteration

Firelines dug in once undisturbed wild areas represent some of the most notable suppression impacts.

Hand fireline generally consist of a trench about two to four feet wide dug to mineral soil. Vegetation is also cleared about six to ten feet beyond the line, and the line is usually reinforced by burnout. Cup trenching and ditches are also constructed to catch rolling embers and burning debris from going beyond the line. Once the line is dug, it is used as a walking trail for the duration of the fire.

Bulldozer fireline is most destructive because it is wider,

deeper, and straighter than handline. Bulldozer line is generally one to two blades wide (15-30 feet). After being constructed, these lines are typically patrolled by hand crews, pumper trucks and supply trucks. Brush piled up alongside the line impedes wildlife movements, and the line forms an unnatural corridor for wildlife.

The detrimental effects of firelines are both ecological and aesthetic. Firelines provide pathways for erosion. They form unnatural trails for wildlife or barriers to migration. The ecology of the line area is changed, as the critical topsoil is lost leaving infertile subsoil. Though revegetation will occur it will be delayed, and a different species mix will probably occupy the site for extended periods. Firelines appear distinctly unnatural. Cleared lines, topsoil berms, and waterbars and other debris are obviously the result of humancaused activities, and these will persist for decades unless otherwise restored to conditions that existed prior to their construction.

Handline:

The basic techniques in recontouring hand fireline are similar to bulldozer work, but on a smaller scale. Hand firelines result in less locally severe impacts, but usually cover much longer distances. Complete obliteration of hand-built firelines will be completed by :using hand tools to recontour the fireline to blend in with the surrounding topography. Cup trenching and ditches which were constructed will be completely obliterated by knocking in the ridge and shaping this fill to match the surrounding terrain.. In situations where handlines have been cut down steep slopes, the bare mineral soil will be scarified on contour, or horizontally. Significantly compacted areas will also be scarified. Berms containing topsoil, duff, and slash shall be raked back over the newly recontoured fireline to a depth of two to four inches. This final organic layer will improve water infiltration and provide protection for germinating seedlings. Slash scattered over the final organic layer will be in a random manner, by feathering the edge to eliminate the appearance of a straight line disturbance. Rocks from berm lines will be scattered, keeping exposed, lichen-covered or weathered sides up. Whenever possible, hand firelines will have permanent photo points established to document conditions of the lines prior to rehabilitation, during rehabilitation work and after restoration work has been completed. Photographs and video tapes may also be taken during subsequent years to monitor the success of the restoration.

Dozer line:

All dozer firelines are usually created using either a bulldozer or front-end loader. The equipment of choice for complete obliteration of these firelines is an hydraulic track mounted excavator. The maneuverability of this machine and the ability

to recontour with minimal additional ground disturbance makes it the ideal machine for complete fireline restoration work. A medium-sized (1.5 cubic yard bucket capacity) excavator will be used on all the dozer firelines. The excavator will also have a clamp attachment on the bucket to help increase the efficiency of retrieving brush, duff, and litter and placing it back onto the finished outslope areas.

In areas where the dozer fireline traversed across a slope creating cuts and fills, the rehabilitation prescription in these areas is to retrieve the fill and place it against the cut slope, and shape the newly outsloped areas to mimic the natural surrounding topography. Before fill is placed against the cut slope, the compacted cut areas will be decompacted (ripped) to a depth of 6 inches using the bucket teeth on the excavator. This will return the natural infiltration process to the area. Once the area has been completely decompacted and recontoured, unburned brush which was cut and pushed to the outside berm to create the fireline will be placed back onto these newly outsloped areas as a natural mulch to reduce surface erosion and provide for a better seedbed for natural regeneration of native plants to the area. In areas where the line crosses boulder fields, boulders will be placed back onto the outsloping to recreate the natural appearance that existed prior to the fireline construction.

Dozer firelines which are constructed on ridge tops will also be completely obliterated using the hydraulic excavator. All surfaces will first be decompacted. Once again, brush, litter and logs will be placed onto the newly shaped slopes to provide natural mulch which will reduce surface erosion. Safety zones will also be decompacted, recontoured if necessary, and mulched with the natural brush, duff and logs. In areas where logs or waterbars are placed back onto the finished slope, care will be taken in their placement so as to not concentrate sheet wash and thus create unnatural surface erosion. Also, logs will only be partially placed onto the recontoured firelines in a manner so they do not give the appearance of an unnatural linear feature across the landscape.

10. Natural Resource Management Assessments

This activity involves the documentation of immediate post-fire effects on threatened and endangered species to determine the need for the development of a species recovery plan. This includes consultation with U.S. Fish and Wildlife and appropriate native plant societies. Emergency rehabilitation funding can be used to fund the salaries and support of staff Resource Management Specialists involved in such activities and, if necessary, the complete development of recovery plans.

Cultural Resources Rehabilitation Measures

1. Archeological Surveys, Compliance and Rehabilitation

- Archeological surveys are mandatory in the following areas impacted by fire:

- fire camps and staging areas; - dozer lines;
- handlines;
- spot assessment of known sites, not necessarily impacted by fire suppression activities (fire-exposed materials).

Surveys vary in their intensity. A 100 percent archeological survey of the above items is appropriate and is defined as systematic location and documentation of sites and artifacts in areas disturbed by suppression activity or with the potential to be impacted by rehabilitation activities in these areas. These sites must be fully recorded and mapped according to Department of Interior standards. Approval of a
100 percent basic inventory survey of the burned areas or data recovery (excavation, testing, point-proveniencing of all artifacts) of every impacted site will not be funded.

- Archeological Compliance: Salary and support for records search, necessary consultation with the State Historic Preservation office, and preparation of documentation required during Section 106 (National Historic Preservation Act, as amended in 1980) compliance. Archeological compliance is required by law if ground disturbance will or has occurred during any project on Federal lands.

- General Rehabilitation/Preservation Techniques for Sites (pending archeological compliance):

A. Data recovery on significant sites that were or will be severely impacted from suppression actions or eroded post fire. Concurrence of research design for data recovery by BIFC and Regional Archeologist prior to initiation of work. Work may include the following rehabilitation:

   1. Physical manipulation of fuels to allow sites to "blend into the landscape." Brush stacked on sites that do not burn will be removed, and fuel will be reduced on sites left as heavily vegetation "islands."

   2. Erosion control (as specified in trail/road rehabilitation): see N1, N2, N3, N4, N8 and N9.

B. Short-term, negotiated protection surveillance (increased law enforcement patrols that are periodic, i.e., not full-time in nature) in park developed areas, major viewsheds, and sites that are readily accessible to the

public.

2. Structural Surveys (Natural Registrar Properties)

A mandatory spot survey (condition assessment) of known structures within the fire perimeter is required. The following activities are funded by emergency rehabilitation funds:

- Condition assessments of each affected or damaged structure by the Regional Historical Architect and/or team. Each assessment will involve a 100 percent survey of damages and the preparation of a detailed report on the rehabilitation of the structure to its original historical significance (salary and support of team members).

- Emergency stabilization of damaged structures including bracing, weatherproofing, removal of water, etc. It may also be necessary to secure structures from entry by the public, including increased security by law enforcement personnel.

Safety Resources Rehabilitation Measures

1. Law Enforcement

The following law enforcement activities may be funded from emergency rehabilitation funds:

- Increased law enforcement patrols of historical structures and known and exposed archeological sites.

- Increased law enforcement patrols for post-fire safety reasons (e.g., traffic control, exposed hazards, unsafe trail conditions).

In either of the above cases, funding is available for salary and support of increased law enforcement patrols over and above regular duty hours only. In all cases, increased activity must be worked into the normal working routines of the available park ranger work force. Protection surveillance working hours must be periodic in nature as opposed to a constant shift and can only occur in park developed zones, major viewsheds and sites that are readily accessible to the public. The procurement of additional law enforcement equipment in support of this activity is prohibited.

2. Structural Inspection (Non-Historic

A visual inspection for structural integrity of all structures affected by fire is required prior to the structure being reopened or made accessible to the public. Inspections will be conducted by either the park safety officer or a park or regional

engineer. A written condition assessment of each affected structure will be submitted to the Superintendent and BIFC as a part of the NPS-Western Region Fire Rehabilitation Plan. The preparation of this assessment is a legitimate FIREPRO emergency rehabilitation funding item. Emergency rehabilitation funding will not be used to develop reconstruction or repair plans or to initiate or complete any of the work outlined in these documents. Unlike historical structures, emergency rehabilitation funds will not be made for temporary support or bracing and weatherproofing of affected developments. For safety purposes, security measures required to block access by the public to damaged structures may be funded by the FIREPRO rehabilitation program.

3. Slash Mitigation

Often times, fire suppression activities result in the accumulation of slash in unnatural and/or hazardous forms. The mitigation of downed slash which is a direct result of suppression actions may be mitigated via FIREPRO emergency rehabilitation funding. The following examples of circumstances which warrant mitigation actions may be used as a guideline:

- Slash accumulation along dozer constructed firelines may need to be scattered in order to facilitate runoff, thus preventing landslides, or expose unburned pockets of_ vegetation or burning stumps.

- The removal of vegetation in close proximity to park development may be necessary to protect such development from fire but, in the .long term, may further perpetuate the fire environment. Such fuels/slash accumulations may be mitigated via FIREPRO.

Generally speaking, fuel or slash mitigation purely for the purposes of promoting "naturalness, 11 restoring visual quality or perpetuating a non threatened and endangered species habitat are not acceptable FIREPRO expenses. Slash removal from a given site via mechanical means or prescribed burning requires prior and specific approval by BIFC via the NPS-Western Region Rehabilitation Plan.

4. Tree Hazards

Timber salvage will not be authorized other than for safety reasons (mitigation of post-fire fuel accumulations). Timber salvage is to be permitted only in developed zones designated in the park General Management Plan.

All other trees to be felled must be killed or damaged directly by the fire or the management thereof and must display an overall hazard rating of 3 in accordance with the Western Region Tree Hazard Rating System (Western Region Tree Hazard Handbook, draft

1991) . Logs to be salvaged will be felled in the same direction, upslope from the direction of removal. Felled trees to be left on site will not be bucked or limbed except in developed zones. Whenever practical and necessary for aesthetic reasons, stumps will by flush cut.

Other Rehabilitation measures

1. Sanitation

The removal of all trash and human-made debris from the burned or staging areas and resulting from suppression activities may be conducted via emergency FIREPRO rehabilitation funding. Legitimate expenses include equipment rental and personnel services.

2. Development Replacement

The replacement of any park development (including access routes) and/or recreational facilities following a wildfire loss is prohibited unless such facilities are absolutely necessary for immediate visitor safety and/or protection and prior and specific approval is received from BIFC via the NPS-Western Region Rehabilitation Plan.

3. Road and/or Bridge Maintenance

The following activities related to road and bridge maintenance post fire activity may be funded with emergency rehabilitation funds (FIREPRO):

- Make repairs on existing roads and bridges damaged during suppression activities.
- Restore surface, grade and shape of permanent roads to prefire condition.
- Install or add water bars on roads where increased runoff is expected.
- Clean and/or enlarge road culverts and channels in preparation for increased runoff.
- Install trash racks to prevent culvert plugging.
- Dust abatement during and immediately following fire suppression.

4. Monitoring

Monitoring, either short or long term, will be funded by emergency FIREPRO rehabilitation funding only when it is performed to meet one of the following objectives:

- To ensure that the treatment or rehabilitation measures are

working as designed.

- To determine when the usefulness of rehabilitation measures has been exhausted.

- To evaluate the immediate post fire invasion of non-native plants and/or animals.

In any case, monitoring activity will only be approved following the submission of a monitoring plan as an attachment to the NPS Western Region Rehabilitation Plan. Under no circumstances will monitoring activity be funded for longer than the proposed rehabilitation period or a maximum of two full growing seasons post burn. All monitoring of vegetation will be done in accordance with the Western Region Fire Monitoring Handbook (1992). Monitoring of vegetation will be approved only when an exotic, fire adaptive species is present pre-fire and a removal or mitigation program was ongoing pre-fire and documented in the park NCRMP.

APPENDIX R. COOPERATIVE AGREEMENTS

Attached are Cooperative Agreements and Memos of Understanding on Presuppression and Fire Suppression Action between Golden Gate National Recreation Area and:

1. Marin County Fire Department
   Sausalito Fire Protection District
   Mill Valley Fire Department
   Tamalpais Fire Protection District
   Muir Beach Volunteer Fire Department
   Stinson Beach Fire Protection District
   Bolinas Fire Protection District

2. City of Pacifica Fire Department