Chapter 4 – Environmental Consequences

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4.1 Regulations and Methodologies

Introduction

This chapter provides a detailed analysis and discussion of the probable environmental consequences, or impacts, of implementing each of the three alternatives. The chapter begins with a discussion of methods used to conduct the environmental impact assessment, including general definitions related to the impact analysis. These are followed by a description of the methods used to assess the type and relative level of impact for each impact topic (e.g., air quality, water quality), including relevant policies, regulations, and assumptions.

Following the sections on impact assessment methodology, the environmental impacts related to each impact topic for Alternatives A, B, and C are addressed. The analysis for each impact topic includes the following:

- Identification of the types of impacts associated with the various actions comprising the alternative;
- Characterization of the impacts, including their duration and intensity;
- Available mitigation measures that would be applied and the effectiveness of these measures on reducing impacts;
- An assessment of cumulative impacts;
- A statement on the potential for implementation of an alternative to impair resources; and
- A conclusion summarizing the findings of the section.

Definition of Terms

Three separate aspects of impacts are described for each impact topic for each alternative: the type of impact, the duration of the impact, and the intensity of the impact. For purposes of this analysis, these descriptors are defined as follows:

Type of impact. The type of impact describes the nature of the overall effect of the impact on the environment. Impacts are described as either beneficial or adverse.

NEPA requires consideration of the direct, indirect, and cumulative impacts of proposed actions. The CEQ regulations (Section 1508.7) define a cumulative impact as “the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions.” Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. “Reasonably foreseeable future actions” include planning or development activities that currently are being implemented or would be implemented in the reasonably foreseeable future.

Duration of impact. The duration of impact is the relative length of time the impact would affect a given resource or value. Under NEPA, impacts are either short-term or long-term and are defined for each impact topic either by specific terminology of time or qualitatively by the passage of a condition. It is important to note that an action that has short-term adverse effects on a resource may have long-term beneficial impacts on the same resource.

Intensity of impact. Intensity describes the degree of the effect on a resource or value. The intensity of each impact is judged as having a negligible, minor, moderate, or major effect. These four designations are used for beneficial as well as adverse impacts.

Impairment. The NPS Organic Act of 1916 and the NPS General Authorities Act of 1970, as amended, require park managers to ensure that park resources and park values remain unimpaired. The discussion of each type of potential effect has a conclusion statement regarding whether or not implementing the alternative would cause resource impairment. Further information on the NPS policy on impairment can be found in Chapter 1, Section 1.4, under "Legislative and Policy Framework."

Cumulative Impact Scenario

Appendix C lists projects that can be considered part of the context of the impact assessment for cumulative effects. The context can vary from impact topic to impact topic. For example, the context for assessing potential cumulative effects on a creek may be all the past, current, reasonable foreseeable future projects that occur on public or private lands that drain to or would occur in that particular creek. The cumulative impact scenario for an isolated rare plant population may be the other two existing populations of the same plant within a relatively short distance. As a starting point for cumulative impact assessment, projects listed in Appendix C are considered in relation to the impact topic under review. Those projects that could contribute cumulatively to the impact area in question are included in the assessment of cumulative impacts. In certain cases, such as air quality effects, additional actions that generate similar impacts are included in the assessment, such as prescribed burning conducted by other agencies in western Marin County. However, the additional prescribed burning would not be relevant to the cumulative projects list of other impact topics in the FEIS, such as visitor experience or special status species. Effects on the tidewater goby are limited to only the three extant water bodies in Marin County where the goby is still found.

Regulations and Methodologies by Impact Topic

The sections that follow describe applicable regulations, policies, and methods used to assess the environmental consequences of the three alternatives on the following impact topics:

Watershed Processes: Soils, Hydrology, Water Quality, and Aquatic Habitat

Air Quality

Vegetation

Wetlands

Wildlife and Important Habitat

Special Status Species (e.g., Threatened, Endangered, Rare, and Sensitive Species)

Cultural Resources

Human Health and Safety

Visitor Use and Visitor Experience

Park Operations

Socioeconomics

Watershed Processes: Soils, Hydrology, Water Quality, and Aquatic Habitat

Policies and Regulations

Watershed resources and processes, including soils, hydrology, and water quality, receive protection under a series of policies and regulations.

Soil resources are subject to the NPS Management Policies 2001 "no impairment" clause that guides NPS decision making to protect the integrity of the important resources and values within the parks (NPS 2000a). The NPS is directed to protect geologic features from the adverse effects of human activity, while allowing natural processes to continue (NPS 2000a). Management action taken by the parks would prevent, to the greatest extent possible, unnatural erosion, physical removal, contamination, and other potentially irreversible impacts on soil (NPS 2000a).

Hydric soils, which are associated with wetland features such as bogs, marshes, and some wetlands, are afforded special protection by Executive Order 11990, Protection of Wetlands, and Clean Water Act Section 404 as regulated by the U.S. Army Corps of Engineers and the State Regional Water Quality Control Board. Specific procedural guidance to NPS staff on the protection of wetlands and areas of hydric soils is outlined in Director's Order 77-1, Wetland Protection (NPS 2002a). Assessment of potential FMP impacts on hydric soils and wetlands is addressed in the "Impacts on the Biological Environment" section of this chapter.

NPS Management Policies 2001 states: "The Service [NPS] will manage watersheds as complete hydrologic systems, and will minimize human disturbance to the natural upland processes that deliver water, sediment, and woody debris to streams. These processes include runoff, erosion, and disturbance to vegetation and soil caused by fire, insects, meteorological events, and mass movement. The Service will achieve the protection of watershed and stream features primarily by avoiding impacts on watershed and riparian vegetation, and by allowing natural fluvial processes to proceed unimpeded." (NPS 2000a).

The Clean Water Act requires the NPS to "comply with all Federal, State, interstate, and local requirements, administrative authority, and process and sanctions respecting the control and abatement of water pollution." The NPS Freshwater Resource Management Guidelines (found in the NPS Natural Resource Management Guidelines [NPS-77]) requires the NPS to "maintain, rehabilitate, and perpetuate the inherent integrity of water resources and aquatic ecosystems."

Assessment Methodology

Water resources, water quality, and soils are interrelated in their reactions to the treatments proposed by the alternatives. Due to these relationships, the analyses of impacts on these resources have been grouped together. Effects upon soils and watersheds are assessed by considering the likely scale of the effect – whether fire would affect all or part of the watershed, and as a result, the likely effect upon water yield, peak flows, sediment yield, nutrient yield, and/or stream system response.

Watershed impacts range from erosion and sedimentation to hydrology and impaired water quality. Hydrology refers to hydrologic processes such as flooding, erosion, deposition, and maintenance of channel patterns. Aquatic habitat refers to the attributes that support or provide habitat within stream or pond systems. Water quality refers to the suitability of surface water for beneficial use, including cold-water or warm-water aquatic wildlife habitat and recreational use.

Long-term impacts on soils include changes to soil chemistry, creation of subsurface hydrophobic layers, changes in soil particle composition or mixing, or loss of the soil profile that may take two years or decades to recover.

Short-term impacts are defined as effects on soil processes that are abated through natural processes or aided by use of standard protective practices within two years of the action.

Actions with negligible impact are those that are either inherently benign or that have effects mitigated to a less-than-detectable level by the procedural standards, such as erosion control practices, implemented as part of the proposal. Actions with negligible impact would be limited in scope and effect to watersheds. For example, a low-intensity prescribed fire may have several limited effects on watersheds, such as a short-term reduction in protective vegetation cover and consequent slight increase in the rate of soil erosion in an area remote from sensitive water resources.

Type of Impact

The following terms and definitions apply:

Beneficial: Protects or enhances properties of native soils, promotes or restores natural soil and hydrologic processes, and protects or improves water quality and aquatic habitat.

Adverse: Degrades the characteristics of native soils, exposes soils to accelerated rates of erosion, results in loss of native soils, contributes to slope failure, alters or degrades natural hydrologic conditions, degrades water quality, or degrades aquatic habitat.

Duration of Impact

The following terms and definitions apply:

Short-term: Impacts are limited to the first two years after treatment or wildland fire.

Long-term Impacts persist two years after treatment or wildland fire.

Intensity of Impact

The following terms and definitions apply:

Negligible: Imperceptible or undetectable.

Minor: Slightly perceptible and localized, without the potential to expand if left untreated; correctable by standard practices for erosion and sediment control.

Moderate: Apparent and localized, with limited potential to expand if left untreated; correctable by standard practices for erosion and sediment control.

Major: Substantial, highly noticeable, with the potential for landscape (watershed)-scale effects. Impacts would compound if left untreated. Treatment requires a site-specific engineered solution.

Air Quality

As in many other national parks near urban areas, the response to wildland fire in GGNRA has been full suppression. One of the results of suppression is the buildup of fuels within the park, increasing the potential for a high-intensity wildland fire to occur. Prescribed burning and mechanical fuel reduction, as proposed in the FMP alternatives, both result in the emission of harmful pollutants to the air but are the primary means to reduce fuel loading. A reduction in fuels lessens the potential for a large destructive fire that could generate much higher air pollution emissions and have significant impacts on regional air quality. The air quality assessment will evaluate the potential impacts of pollutants generated by the maximum allowable acreage that can be treated by prescribed burning and mechanical treatment for each of the FMP alternatives.

Policies and Regulations

Federal Clean Air Act and the Environmental Protection Agency

The Clean Air Act (CAA) charges the Environmental Protection Agency (EPA) with identifying national ambient air quality standards (NAAQS) to protect public health and welfare. Standards have been set for seven pollutants: ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter less than 10 microns (PM_{10}), very fine particulate matter less than 2.5 microns in diameter ($PM_{2.5}$), and lead (Pb). Section 176 of the CAA requires federal actions to conform to state implementation plans for achieving and maintaining the air quality standards. Federal actions cannot cause or contribute to new violations, increase the frequency or severity of any existing violation, interfere with timely attainment or maintenance of a standard, delay emission reduction milestones, or contradict the State Implementation Plan. If a NAAQS is exceeded within an air basin, the entire air basin is considered a nonattainment area and is then subject to more stringent planning and pollution control requirements. The Bay Area Basin is currently in nonattainment status for state and federal standards for ozone and state standards for particulate matter. The current federal and state ambient air quality standards and the federal and state attainment status for the Bay Area Air Basin are presented in Chapter 3, Table 3-4.

The EPA has developed regional haze regulations to improve visibility or visual air quality in national parks and wilderness areas across the country. In developing these rules, the EPA recognized that both prescribed and wildland fires contribute to regional haze and that there is a complex relationship between what is considered a natural source of fire versus a human-caused source of fire. In many instances, the purpose of prescribed fires is to restore a fire regime to forest ecosystems to prevent future catastrophic fires that can detrimentally affect an air basin's air quality. The EPA works to support state and federal land managers in the development of enhanced smoke management plans to minimize the effects of fire emissions from prescribed fires on public health and welfare.

Regional Haze and the Western Regional Air Partnership

On a regional scale, smoke emissions can contribute significantly to haze and degradation of visibility. Regional haze issues in the U.S. are being addressed through a national regional haze process that has set as its goal the restoration of natural visibility conditions by 2064 in Class I areas of the country. Established by the CAA, Class I areas are places where pollution prevention is given a special priority; they include national parks established before 1977 with a total acreage above a certain minimum requirement. The air quality standard and the degree of visibility in Class I areas were established to serve as baseline barometers to track changes in emission levels since 1977. Examples of Class I areas are Point Reyes National Seashore, Grand Canyon National Park, and Yosemite National Park. GGNRA was designated as a Class II area, where some incremental increase in emission levels is allowed based on the proximity of a population center.

To develop solutions on a regional scale, the federal government has set up five regional haze working groups made up of groups of states. California participates in the Western Regional Air Partnership (WRAP) comprising all states west of Kansas. Each state in the WRAP will develop an implementation plan to augment the state's smoke management plan by 2018 – the deadline to adopt control measures that will effectively allow the state to meet the 2064 goal. Effectiveness of the control measures must be supported by modeling the projection of conditions to that date. Because the issue of regional haze is being addressed by this long-term regional process, the assessment of the effects of FMP implementation on visibility is limited in scope to the impairment of local visibility.

California Clean Air Act and the California Air Resources Board

The federal government has ceded responsibility and authority to establish air quality standards and regulations to the states. Therefore, all NPS areas are required to comply with state laws on these matters regardless of the type of legal jurisdiction that applies to other activities within the NPS unit.

To protect public health and welfare, the California Air Resources Board (CARB) has set ambient air quality standards that are stricter than federal standards. Under the 1988 California Clean Air Act, air basins are designated as attainment, nonattainment, or unclassified for the state standards.

State implementation plans (SIPs) identify measures designed to bring the nonattainment areas into attainment. Basic components of SIPs include legal authority, an emissions inventory, an air quality monitoring network, control strategy demonstration modeling, emission-limiting regulations, new source

review provisions, enforcement and surveillance strategies, and other programs necessary to attain standards.

The CARB is responsible for disseminating regulations about air quality, including state ambient air quality standards and area designations; emissions from motor vehicles, fuels, and consumer products; and airborne toxic control measures. Title 17 of the California Code of Regulations, titled Smoke Management Guidelines for Agricultural and Prescribed Burning, provides direction to air pollution control and air quality management districts for the regulation and control of agricultural burning, which includes prescribed burning. The guidelines are intended to allow the use of prescribed burning as a management tool while minimizing smoke impacts on the public.

San Francisco Bay Area Air Quality Management District (BAAQMD)

BAAQMD is the air quality management district for the planning area and has primary responsibility for enforcing and issuing permits under the CAA for prescribed burning. GGNRA prescribed burns must comply with BAAQMD's Regulation 5 and smoke management program, which govern open burning in the Bay Area Air Basin. For all prescribed fires, BAAQMD requires GGNRA to submit an individual smoke management plan at least one month before the proposed burn. BAAQMD then issues a forecast 72 hours before the proposed date and gives a final commitment to permit the burn on the day of the burn itself, though forecasts with increasing confidence can be obtained at 96 hours, 72 hours, 48 hours, and 24 hours before the burn day to support moving forward on all the logistical planning needed to conduct a prescribed burn.

Federal Policies and NPS Guidance

NPS Management Policies 2001 directs superintendents to comply with all federal, state, and local air quality regulations and permitting requirements when conducting prescribed burns (NPS 2000a). In addition to the requirements of the CAA, specific guidance has been developed by the EPA to address prescribed burning. These are supplemented by guidance and policies such as the Federal Wildland Fire Management Policy (Interagency Working Group 2001) and the EPA's Interim Air Quality Policy on Wildland and Prescribed Fires (EPA 1998). These policies established the need and requirements for state and tribal smoke management programs to (1) mitigate impacts on air quality (even when below the NAAQS) and public safety (such as visibility on roads and airports) posed by smoke intrusions into populated areas, (2) prevent significant deterioration of air quality and NAAQS violations, and (3) address visibility impacts in Class I areas. With the adoption by a state of a smoke management program, certain PM_{10} exceedances attributable to fires, including some prescribed fires and managed wildland fires, can be excluded from air quality data sets used to determine violations for a state. Through these policies, federal agencies are directed to consider ambient air quality above the NAAQS for $PM_{2.5}$ and PM_{10} as the principal indicator of adverse impacts on public health. Poor visibility is used as the principal indicator of adverse impact on public welfare. The EPA's Natural Events Policy addresses public health impacts from wildland fires (EPA 1996).

An objective of CARB and NPS directives is to minimize smoke impacts on people and on sensitive receptors in and near national parks. Sensitive receptors can include towns, villages, hospitals, schools, nursing homes, campgrounds, trails, scenic vistas, and Class I areas. Selection of sensitive receptors is

based on guidance from the California Code of Regulations Title 17, Smoke Management Guidelines for Agricultural and Prescribed Burning, and consideration of the local setting, including demographics, wind patterns, and local climatic conditions.

NPS-77 (Reference Manual 77: Natural Resource Management) states: "The National Park Service will seek to perpetuate the best possible air quality in parks because of its critical importance to visitor enjoyment, human health, scenic vistas, and the preservation of natural systems and cultural resources. The Park Service will assume an aggressive role in promoting and pursuing measures to safeguard [air quality related values] from the adverse impacts of air pollution. In cases of doubt as to the impacts of existing or potential air pollution on park resources, the Park Service will err on the side of protecting air quality and related values for future generations" (NPS 1991).

Assessment Methodology

Fire management actions could affect air quality in the project area through smoke emissions from wildland and prescribed fires. The impacts of particulate matter and other pollutants on firefighter and public health from exposure to smoke are discussed in this FEIS under "Human Health and Safety" below.

The emission levels generated by the use of machinery for fire management actions (i.e., mechanical fuel reduction projects, site preparation for prescribed burns, etc.) has been determined by the NPS Air Resources Division to be negligible in comparison to levels generated by smoke emissions; therefore, the impact assessment focuses on emissions generated by smoke.

BAAQMD data do not reflect the level of emissions produced by the No Action alternative (Alternative A), as no prescribed burning has occurred in GGNRA parklands recently enough to be accounted for in BAAQMD data sampling used to discuss ambient air quality in the Bay Area.

Method of Estimating Smoke Emission

The First Order Fire Effects Model 5.21 (FOFEM) was used to generate emission factors for PM_{10}, $PM_{2.5}$, VOC (volatile organic compounds), CO (carbon monoxide), NO_x (nitrogen dioxide), and SO_2 (sulfur dioxide) for the maximum allowable fire management actions under each alternative. FOFEM is a computer-based model that provides quantitative predictions for planning prescribed fires and conducting impact assessments, and for long-range planning and policy development. FOFEM is the standard modeling program used to demonstrate conformity with applicable environmental impact rules and regulations. The model also provides fire effects information on potential tree mortality, fuel consumption, mineral soil exposure, and smoke generation (Reinhardt 1997). The smoke module of FOFEM does not predict smoke dispersion or model the impairment of local visibility.

The FOFEM smoke module requires a number of inputs related to burn characteristics, such as fuel category, cover type, fuel loading, moisture content, and percent of crown burn. For this assessment, GGNRA fire management staff described representative burn parameters for each burn unit. The area of each cover type in a given prescribed burn unit was determined based on the expertise of the fire management staff and vegetation mapping of the planning area. The burn unit cover types were then correlated with the Society of American Foresters (SAF)/Society for Range Management (SRM)

vegetation types for use in the FOFEM model. Where a direct correlation between cover types was not possible, a surrogate SAF/SRM cover type was selected. Table 4-1 provides a cross-reference for cover types.

Table 4-1: Vegetation Cover Types Used in Air Quality Emissions Analysis

Fire Management Vegetation Class	SAF[1]/SRM[2] Type
Valley grassland, annual grassland	SRM 208
Ceanothus, mixed chaparral	SRM 215
Pacific Douglas-fir	SAF 229

Notes:
[1]Society of American Foresters (SAF)
[2]Society for Range Management (SRM)

The results of the FOFEM model were used to develop average emission factors (per acre) that are used to quantify the amount of pollutants generated by the maximum prescription burning allowed for each alternative. For a given prescribed burn unit and pollutant, the emissions were quantified by the following equation:

$$E = \sum_{c=1}^{n} EFc * Ac, \text{ where}$$

E = emissions in tons/year

Efc = emission factor for coverage c in tons/acre

Ac = area of coverage in acres

Separate FOFEM runs were used to develop emission factors for wildland fires in natural forest, since these typically burn under drier conditions and consume more fuel, particularly crown and branch fuels, and produce higher emissions. NPS Air Resources Division staff provided burn parameters based on recent wildland fires to model these emissions. Emission factors for grassland and coastal scrub are the same for these fuel types in both prescribed burning and wildfires (see Table 4-4). The cover and vegetation type from the PRNS FMP analysis were used as surrogates for the GGNRA analysis.

Pile Burning

A number of assumptions were made to calculate burn pile emissions, as FOFEM provides emission factors in pounds per acre and not in pounds per burn pile. First, the emission factors generated by FOFEM were normalized to tons of fuel load (pre-burn) to give emission factors on a pound-per-ton basis. Second, the tonnage of each burn pile was calculated using assumptions taken from the U.S. Forest Service General Technical Report NW-GTR-364 (USFS 1996), which involves the following steps:

Step 1. Calculating pile tonnage to be equal to pile volume x 30 pounds per square foot x 0.2 (packing ratio).

Step 2. Giving a tonnage of 0.108 ton per burn pile for the four cubic yard piles typically constructed at GGNRA and used in the GGNRA FMP.

Step 3. Modeling the burn piles after Pacific Douglas-fir wood. [Note: FOFEM, a forestry model, does not have built-in emission factors for eucalyptus among the vegetation types considered in the software package. FOFEM does not fully model "pile burns;" rather, it models them like natural burns and may therefore underestimate emissions generated.]

Both the prescribed and wildland fire emission factors predicted by FOFEM are higher than similar emission factors in the EPA's Compilation of Air Pollution Emission Factors (AP-42) for the same region. However, the AP-42 derived emission factors are generalized for large regions and "can vary by as much as 50 percent with fuel and fire conditions" (EPA 1996). Since fuel loading in many areas of GGNRA may be heavier than normal due to decades of fire suppression, the emission factors used here can be considered to better represent GGNRA conditions. Emission factors used for prescribed burning, wildfire, and pile burning are shown in Table 4-2.

Table 4-2: Smoke Emission Factors by Fire Type

GGNRA Cover Type	FOFEM Surrogate	Code	Emission Factors (pounds/acre)						
			Fire Type	PM_{10}	$PM_{2.5}$	VOC	CO	NOx	SO_2
Coastal Scrub	Ceanothus	SRM 208	Prescribed	190	161	49	404	198	62
Grass	Valley Grassland	SRM 215	Prescribed	11	9	3	23	12	4
Native Forest	Pacific Douglas-fir	SAF 229	Prescribed	2863	2445	1480	32319	24	114
Coastal Scrub	Ceanothus	SRM 208	Wild	190	161	49	404	198	62
Grass	Valley Grassland	SRM 215	Wild	11	9	3	23	12	4
Native Forest	Pacific Douglas-fir	SAF 229	Wild	3640	3085	1867	40836	31	145
Nonnative Trees	Pacific Douglas-fir	SRM 229	Pile	2660	2254	1329	28606	162	145

Source: NPS 2004.
Notes:
PM_{10} = suspended particulate matter, $PM_{2.5}$ = fine particulate matter, VOC = volatile organic compounds, CH_4 = methane, CO = carbon monoxide, NOx = nitrogen oxides
Grass = Society for Range Management (SRM) 208 vegetation areas
Brush = SRM 215 vegetation areas
Forest = Society of American Foresters (SAF) 229 vegetation areas

Annual inputs for wildland fire are based on 39 acres burned per year during three to five fire starts, a conservative estimate of wildland fire in GGNRA according to the fire management officer (Naar 2004). The wildfire acreage consists of 25 acres of grassland, 12 acres of shrublands, and 2 forested acres. The low incidence and limited acreage of wildland fire annually in the study area are due primarily to a very low incidence of deliberate and unintentional fire starts by the public and the wetter than usual

summertime conditions in the coastal portions of GGNRA as compared to the hot drier inland summer of the rest of the coast range.

The number of acres of wildfire is consistent throughout the alternatives. Emissions generated by mechanical treatment are also assumed to be consistent and negligible in each alternative (see discussion below under "Emissions from Mechanical Treatment"). Therefore, the difference in estimated annual emissions for the three alternatives is due to the maximum allowable acreage of prescribed fire under each alternative.

Emissions from Mechanical Treatments

Negligible levels of air pollutants would be generated by fuel reduction projects and during preparation of burn units for prescribed burning projects. Motorized equipment used in thinning and site preparation activities could include chain saws, brushcutters, mowers, chippers, excavators, skidders, frontloaders, and haul trucks. The types of equipment shown in Table 4-3 are a representative sample of the types of equipment used in GGNRA. FMPs prepared for other western national parks have consistently found that pollutants generated by equipment contribute a very small amount to overall emissions where plans include prescribed burning. For example, in the emission estimates calculated for equipment use in mechanical fuel treatment and preparation for prescribed burning for the PRNS FMP, emissions from equipment did not exceed 2 percent of the total emissions generated. In most cases, emission levels calculated were less than 1 percent of the total (NPS 2004a). The Yosemite FMP found equipment emissions were consistently less than 1 percent of the total emissions generated by equipment use in all actions. Table 4-3 shows the factors that were used to calculate emissions from equipment use for the PRNS and Yosemite FMP alternatives, which yielded the relatively negligible emission levels from equipment in those assessments. The contribution of vehicle and equipment emissions to total emissions would be of similar equivalence for the GGNRA FMP; therefore, the NPS Air Resources Division considers emissions from equipment use a negligible contributor to air quality impacts from FMP implementation.

Table 4-3a: Emission Factors for Equipment Use in Fire Management Activities

Operating Parameters			Emission Factor (pounds per hour)1			
Machine Type	**Fuel Type**	**Average HP**	**CO**	**PM**	**NOx**	**VOC**
Chainsaw	Gasoline	6	3.4	0.05	0.01	1.1
Mower	Gasoline	50	30.6	0.26	0.26	0.39
Skidder	Diesel	200	4.4	0.57	3.0	0.95
Haul truck	Diesel	200	4.4	0.57	3.0	0.95

Source: NPS 2004.

Average HP = average horsepower, CO = carbon monoxide, PM = particulate matter, NOx = nitrogen oxides, VOC = volatile organic compounds (total hydrocarbons) such as methane (CH_4).

Type of Impact

The following terms and definitions apply:

Beneficial: Improves or maintains air quality while lowering the potential for significant short-term pollutant release events.

Adverse: Degrades current air quality.

Duration of Impact

The behavior of a smoke plume from a fire, including the direction and elevation of the plume and resulting concentrations at ground level, is highly dependent on elevation and dynamic meteorological conditions at the time. Under prescription conditions, air quality emissions generated by prescribed burning or wildland fire would disperse within a timeframe roughly the same as the duration of the fire management action. An exception to this would be if smoke from a fire became trapped at low altitudes in an inversion layer that can occur in the fall or winter.

The following terms and definitions apply to the analysis:

Short-term Effects on air quality last less than three days beyond the duration of the fire management action.

Long-term Effects on air quality persist beyond the duration of the fire management actions, or are annually recurrent throughout the implementation period of the FMP.

Intensity of Impact

Localized Effects of Smoke (Visibility)

The assessment of effects of FMP actions on regional haze focuses on the impairment of local visibility. Effects of smoke on traffic safety are addressed under “Impacts on Human Health and Safety” below. The following terms and definitions apply:

Negligible: Smoke would be barely perceptible or detectable and affect an undeveloped area (no recreational facilities or trails, no habitable structures, etc.).

Minor: Smoke would be detectable but localized within an area of low-density development for recreational or private use, of short duration (several hours), and have no lasting effects.

Moderate: Smoke would be readily perceptible but localized in an area of low-density development, and be sufficient to limit use of the area for one day or less without damage to property or lasting effect.

Major: Smoke would be readily noticeable, and would occur in a developed area with a potential hazard to human health or create property damage or lasting effect.

Effects on Bay Area Air Basin Air Quality and Conformance with the State Implementation Plan

When air quality within a region or airshed deteriorates below one or more of the National Ambient Air Quality Standards (NAAQS), a state must develop a State Implementation Plan (SIP) to improve the air quality. The means of achieving the standard is determined largely by the state. The regulators may decide to severely limit prescribed burning, or they may focus on some other pollutant source.

Voluntary Smoke Management Program (SMP) developed by states must then be certified by the EPA. Once the SMP is certified and in use, the EPA will allow two exceedances of the NAAQS for PM2.5 attributable to prescribed burning without declaring the region out of attainment. The states will instead be allowed to review their SMP and make adjustments if it is found inadequate. If fires cause or significantly contribute to a third consecutive NAAQS violation, EPA will call for the SMP to be made part of the SIP and be federally-enforceable. If the area was designated nonattainment previously, EPA will also call on the State to review the effectiveness of the SMP and make appropriate improvements.

The NPS has developed interim guidelines for determining potential airborne pollution impacts on human health and park resources (NPS 2003c). Thresholds set for intensity of effect are based in part on the emission thresholds, which define *de minimus* projects for purposes of providing determination of conformance with national ambient air quality standards and the SIP.

The *de minimus* levels are the minimum thresholds for which a conformity determination must be performed for the various criteria pollutants in nonattainment or maintenance status in the air basin. Federal agencies only need to perform a general conformity analysis if emissions from a proposed action are not accounted for in the air district's State Implementation Plan (SIP) for that emission. The conformity determination shows how the emissions generated by the implementation of a project or plan will conform to the air basin's strategy to control emissions of a criteria pollutant.

Table 4-3b: *De Minimus* Levels for State Implementation Plan Conformance

Pollutant	Area Type	Tons/Year
Ozone (VOC or NOx)	Serious nonattainment	50
	Severe nonattainment	25
	Extreme nonattainment	10
	Other areas outside an ozone transport region	100
Ozone (NOx)	Marginal and moderate nonattainment inside an ozone transport region	100
	Maintenance	100
Ozone (VOC)	Marginal and moderate nonattainment inside an ozone transport region	50
	Maintenance within an ozone transport region	50
	Maintenance outside an ozone transport region	100
CO, SO_2 & NO_2	All nonattainment & maintenance	100
PM-10	Serious nonattainment	70
	Moderate nonattainment and maintenance	100

Source: BAAQMD, 2005

Notes:

NOx = nitrogen oxides, VOC = volatile organic compounds, CO = carbon monoxide, SO_2 = sulfur dioxide, NO_2 = nitrogen dioxide, PM10 = suspended particulate matter

Though the Bay Area Air Basin is now in attainment with national air quality standards for CO, its maintenance status indicates that exceedences of the CO standard have occurred in the past. The air basin is implementing a plan to maintain a lower level of CO generation. According to the BAAQMD CO maintenance plan, urbanized areas of San Mateo and Marin counties are within the Bay Area Air Basin maintenance area for CO.

The Bay Area Air Basin is rated as being in nonattainment with federal standards for ozone precursors (NOx and VOC). For purposes of CAA conformance, the Bay Area Air Basin is not considered a "transport" area – an area that receives pollution from an adjoining air basin. These factors help define the level considered *de minimus* above which projects are considered as contributors to the air basin nonattainment status for ozone precursors.

Federal actions with the potential to produce NOx or VOC emissions exceeding the *de minimus* level must include a conformity determination showing how the action incorporates SIP strategies for reducing the levels of ozone precursors to the federal standard and achieving attainment. Federal actions with the potential to produce emissions below the *de minimus* level are exempt from the conformity requirement. Conformity requirements do not apply to the state standards for emissions. Only federal standards are addressed by the SIP. For federal actions and planning efforts, such as an FMP, where conditions do not involve a new air pollution source but rather are ongoing, impact levels and potential for impairment are assessed relative to the natural condition (attainment status) in addition to incremental change from the No Action alternative (Alternative A).

For considering the potential intensity of effect of the FMP on levels of pollutants with which the Bay Area Air Basin is currently in attainment status (SO_2, PM_{10}, and NOx), the following thresholds apply:

Negligible: Less than 50 tons per year (each pollutant).

Minor: More than 50 tons per year and less than 100 tons per year (each pollutant).

Moderate: More than 100 tons per year.

Major: More than 250 tons per year.

For considering the potential intensity of effect of the FMP on levels of pollutants with which the Bay Area Air Basin is currently in marginal nonattainment status for federal standards on ozone (represented by VOC), the following thresholds apply:

Negligible: Net decrease in emissions from current levels.

Minor: 1 to 50 tons per year.

Moderate: More than 50 tons per year and less than the conformity *de minimus* levels (conformity *de minimus* levels = 100 tons per year).

Major: More than or equal to the conformity *de minimus* levels (conformity *de minimus* levels = 100 tons per year).

Vegetation

Policies and Regulations

NPS Management Policies 2001 states that "the National Park Service will maintain as parts of the natural ecosystems of parks all native plants and animals" (NPS 2000a). The policies go on to state that "all cultural and natural resource values will be considered in defining specific treatment and management goals," and that:

- Flowering plants, ferns, mosses, lichens, algae, fungi, and microscopic plants are included;
- The natural abundances, diversities, dynamics, distributions, habitats, and behaviors of these native species are preserved and protected; and
- The introduction of nonnative species into units of the national park system should be prevented.

The policy manual NPS-77, Natural Resource Management (NPS 1991) also provides general guidelines on vegetation management.

Assessment Methodology

The park's vegetation was interpreted and mapped from 1994 aerial photographs. Plant communities were delineated in this mapping effort using field data collected in 2001, and the classification of alliances and associations (roughly based on Sawyer and Keeler-Wolf 1995) was completed in 2003. For purposes of this document, these alliances and associations have been grouped together into 10 broad "fire management communities" that are described in Chapter 3 (Affected Environment). These fire management communities all share species with similar growth forms, structural attributes, and/or fire behavior characteristics; thus it is assumed that they would respond similarly to treatments that would be applied under the FMP. The grouping of vegetation types into fire management communities and the extent of area covered by each community was conducted using a Geographic Information System (GIS).

The primary assessment of impacts on vegetation considers potential impacts of all fire management activities, regardless of vegetation community. This is followed by special considerations and impacts unique to individual communities, including the following parameters:

- Fire ecology (past and present) of the dominant species in the vegetation community, including fuel loads and potential for vegetation type changes;
- Areal extent and relative abundance or rarity of the vegetation community in the project area and in the region; and
- Abundance and species richness of nonnative plants within or adjacent to the vegetation communities affected.

The abundance, as defined by extent of coverage, of an individual vegetation community is important when considering impacts because the park is mandated to protect and maintain all native plant communities. In a vegetation community that is rare in the FMP area or the region, such as chaparral, adverse impacts may be more significant.

The presence and abundance of nonnative plants in or around the affected vegetation community are an important consideration, as many nonnative plant species are stimulated to grow or reproduce as a result of fire or other disturbance. Some nonnative plant species can have substantial adverse effects on native vegetation, including the following:

- Nonnative plants can out-compete native plants for light, nutrients, water, and growing space, which, in the worst case, can lead to extinction or local extirpation of rare plant species;
- Nonnative plants can degrade the quality of wildlife habitat by out-competing native food sources, or altering nesting or resting habitat;
- Nonnative plants can disrupt the genetic integrity of native plants if crossbreeding occurs; and
- Nonnative plants can change fire regimes by converting habitat types (e.g., converting a shrub or forested landscape with little understory to one that has a continuous herbaceous layer, or converting an open grassland to forest).

Fire can also be used as a tool, in conjunction with other management activities, to control nonnative plant species, and the abundance and density of these plants in comparison to the native plant component can be an important factor in evaluating the potential effects of treatment actions. For example, a site with 100-percent cover of a nonnative grass could benefit from seasonal burning to favor native perennial grass species.

Much of the information on individual vegetation communities focuses on a few dominant or typical species and the effects of fire on these species. Information on individual plant species was largely derived from the Fire Effects Information System (FEIS), available online at http://www.fs.fed.us/database/feis/. This database includes comprehensive bibliographies for each species. Community information was developed from a variety of sources included in Appendix B of this document.

Type of Impact

The following terms and definitions apply:

Adverse: Decreases the areal extent or native species richness of a plant community, results in a native plant community type conversion, or increases nonnative plant species abundance or richness.

Beneficial: Increases the areal extent or native species richness of a plant community, or decreases nonnative plant species abundance or richness.

Duration of Impact

The following terms and definitions apply:

Short-term: Would be measurable for two years or less.

Long-term: Would be measurable for longer than two years.

Intensity of Impact

The following terms and definitions apply:

Negligible: Would result in no measurable changes in plant community areal extent, or in native or nonnative species richness within a plant community.

Minor: Changes in plant community areal extent, or in native or nonnative species richness within a plant community, would be measurable, and would affect less than 5 percent of the total extent of that plant community in the planning area.

Moderate: Changes in areal extent, or in native or nonnative species richness within a plant community, would be measurable, and would affect between 5 and 25 percent of the total extent of that plant community in the planning area.

Major: Changes in areal extent, or in native or nonnative species richness within a plant community, would be measurable, and would affect over 25 percent of the total extent of that plant community in the planning area.

Wetlands

Policies and Regulations

Wetlands are addressed separately from the vegetation analysis because they are defined by unique attributes of vegetation, hydrology, and soils and protected by specific regulations and orders. Wetlands are lands that are transitional between terrestrial and aquatic systems, where the water table is usually at or near the surface, or the land is covered by shallow water. Wetlands buffer the effects of hydrologic and erosional cycles, influence biogeochemical cycles of nitrogen and other key nutrients, and create valuable habitat for animal and plant species.

As a result of these important attributes, wetlands are protected by a specific set of laws and regulations. The protection of wetlands within NPS units is facilitated through the following:

- Executive Order 11990, Protection of Wetlands.
- NPS Director's Order 77-1, Wetland Protection, and its accompanying Procedural Manual 77-1 (DO 77-1 and PM 77-1).
- Rivers and Harbors Act, Section 10.

- Clean Water Act, Section 404.
- The "no net loss" goal outlined by the White House Office on Environmental Policy in 1993.

Executive Order 11990 requires that agencies work to minimize the destruction, loss, or degradation of wetlands. Director's Order 77-1: Wetlands Protection, and Procedural Manual 77-1 (NPS 2002a) provide specific procedures for implementing Executive Order 11990. Director's Order 77-1 states that NPS adopts a goal of "no net loss of wetlands." In addition, the NPS will strive to achieve a longer-term goal of net gain of wetlands Service-wide. For undertakings that could affect wetlands, the NPS will take the following measures:

a) avoid adverse wetland impacts to the extent practicable,

b) minimize impacts that cannot be avoided, and

c) compensate for remaining unavoidable adverse wetland impacts via restoration of degraded wetlands.

If the preferred alternative in an EA or EIS will result in adverse impacts to wetlands, a "Statement of Findings" documenting compliance with Director's Order 77-1 and Procedural Manual 77-1 will be completed. In addition, all applicable permits sought will be consistent with Section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act, which authorize the U.S. Army Corps of Engineers (USACE) to grant permits for construction and disposal of dredged material in waters of the United States, including wetlands.

Assessment Methodology

For this assessment, wetlands that could be subject to impacts were identified using the GGNRA vegetation map and field-mapped wetland data, when available. These data layers then were overlain with the boundaries of the 10 fire management units. This information provided a conservative and broad estimate of the extent of known and potential wetlands within the planning area.

The parameters that were considered in the assessment of impacts on wetlands include the following:

- Plant species composition of the wetland;
- Hydrologic features that maintain the wetland; and
- Wetland soils.

These parameters parallel those used by the USACE, the agency granted the authority under the Clean Water Act to regulate wetlands. It is assumed that if these parameters are altered as a result of fire management activities, the wetland would be subject to impacts, which could be either beneficial or adverse.

Type of Impact

The following terms and definitions apply:

Adverse: Shifts plant species composition to a higher percentage of nonwetland indicator species or allows invasion by nonnative species; alters hydrologic features/factors that are required to maintain the wetland; alters soil properties that are required to maintain the wetland; or reduces areal extent of wetlands.

Beneficial: Enhances native wetland vegetation, soils, or hydrology, or increases areal extent of wetlands.

Duration of Impact

The following terms and definitions apply:

Short-term: Would be measurable for two years or less.

Long-term: Would be measurable for longer than two years.

Intensity of Impact

The following terms and definitions apply:

No Effect: No measurable changes in the areal extent of wetlands, or in wetland vegetation, soils, or hydrology, would result.

Minor: Changes in the areal extent, or in wetland vegetation, soils, or hydrology, would be measurable but would affect less than 5 percent of the total extent of the wetland type in the FMP project area.

Moderate: Changes in the areal extent, or in wetland vegetation, soils, or hydrology, would be measurable but would affect less than 20 percent of the total extent of the wetland type in the FMP project area.

Major: Changes in the areal extent, or in wetland vegetation, soils, or hydrology, would be measurable and would affect 20 percent or more of the total extent of the plant community in the FMP project area.

Wildlife and Important Habitat

Policies and Regulations

NPS Management Policies 2001 states that “the National Park Service will maintain as parts of the natural ecosystems of parks all native plants and animals” (NPS 2000a). The policy statement includes bacteria, mammals, birds, reptiles, amphibians, fishes, arthropods, worms, and microscopic animals. The NPS is to preserve and restore the natural abundance, diversities, dynamics, distributions, habitats, and behaviors of these native species. Additionally, the NPS is to prevent the introduction of nonnative species into units

of the national park system (NPS 2000a). NPS-77 (Natural Resource Management Guidelines) also provides general guidelines on wildlife management (NPS 1991).

The NPS also is required to comply with the Fish and Wildlife Coordination Act (1934), the Marine Mammal Protection Act (1972), the Bald and Golden Eagles Protection Act (1940), the Convention on International Trade in Endangered Species (1973), and maritime and other international agreements. In addition, the NPS is required to comply with the Migratory Bird Treaty Act (1918) as amended, which prohibits taking, killing, or possessing migratory birds, nests, or eggs. California Department of Fish and Game regulations govern fishing in coastal areas leased by GGNRA.

Assessment Methodology

Many of the impacts of fire management actions on wildlife can be assessed by considering the effects of actions on wildlife habitat as represented by general vegetation types. In general, adverse effects on wildlife can be minimized by reducing and limiting habitat fragmentation – that is, by preserving and restoring large areas as well as patches of habitat, and maintaining connections within and among habitat types. Larger patches of habitat tend to support higher numbers and diversity of wildlife species than smaller ones, and connections between habitat patches enable the movement of wildlife between areas, enhancing reproduction and survival. Small patches of habitat can serve as stepping stones for wildlife moving between larger blocks, or as isolated refuges for wildlife in areas that have been highly developed by humans.

The value of habitat patches for wildlife is also affected by adjacent human activities and development. Severe disruption of habitat corridors can impede wildlife movements. Impacts radiating into habitat patches, such as impacts from noise, nonnative species, and human use, can adversely affect habitat quality. Core areas that are more isolated from these impacts generally provide higher quality habitat for wildlife.

Impacts on wildlife have been assessed in terms of the following:

- Changes in the amount and distribution of wildlife habitat;
- Changes in the size and connectivity of habitat patches; and
- The existing integrity/quality of affected habitats (including past disturbances), and the relative importance of affected habitats.

Type of Impact

The following terms and definitions apply:

Adverse: Would negatively affect the size, continuity, or integrity of wildlife habitat.

Beneficial: Would positively affect the size, continuity, or integrity of wildlife habitat.

Duration of Impact

The following terms and definitions apply:

Short-term: Would be expected to last for less than two years.

Long-term: Would last two years or longer.

Intensity of Impact

The following terms and definitions apply:

Negligible: Would not be measurable or perceptible.

Minor: Would be measurable or perceptible and would be localized within a relatively small area; however, the overall viability of the resource would not be affected. Without further impacts, minor adverse effects would be reversed, and the resource would recover.

Moderate: Would be sufficient to cause a change in the resource (e.g., abundance, distribution, quantity, or quality); however, the impact would remain localized. The change would be measurable, but negative effects could be reversed in the long term.

Major: Would be substantial, highly noticeable, measurable, and could be irreversible (permanent). The resource would be unlikely to recover.

Special Status Species

Policies and Regulations

Numerous species of plants and animals have undergone local, state, or national declines, which have raised concerns about the species' possible extinction if they are not protected. As a result, the U.S. Fish and Wildlife Service (USFWS) and the California Department of Fish and Game (CDFG) have established lists that reflect the species' status and the need for monitoring, protection, and recovery. The NPS also recognizes a number of species as locally rare or of special concern, such as plants listed by the California Native Plant Society (CNPS), even though they are not yet officially protected by legislation. Collectively, species in all of these categories are referred to in this document as "special status species."

The federal Endangered Species Act (ESA) of 1973, as amended, provides that federal agencies will use their authorities by carrying out programs for the conservation of endangered and threatened species. Furthermore, federal agencies are required to consult with the USFWS before taking actions that (1) could jeopardize the continued existence of any federally listed plant or animal species (e.g., listed as threatened or endangered) or species proposed for listing, or (2) could result in the destruction or adverse modification of critical or proposed critical habitat. The USFWS has provided the species listed under the ESA that must be considered for this EIS.

The Council of Environmental Quality's Regulations for Implementing NEPA (Section 1508.27) requires consideration of whether an action may violate federal, state, or local laws or requirements imposed for

the protection of the environment. For this reason, species listed or proposed for listing as endangered or threatened under the California Endangered Species Act are included in this analysis.

Other applicable legislation, policies, and agreements that provide the authority for NPS policies on management of threatened and endangered species include the following:

- Other state wildlife statutes or agreements pursuant to Section 6 (ESA);
- Migratory Bird Conservation Act (1918);
- Fish and Wildlife Coordination Act (1934);
- Marine Mammal Protection Act (1972);
- Magnuson-Stevens Fishery Conservation and Management Act (as amended 1996);
- Bald and Golden Eagles Protection Act (1940);
- Convention on International Trade in Endangered Species (1973); and
- Maritime and other international agreements.

The USFWS takes lead responsibility for coordinating and implementing provisions of the Endangered Species Act for all terrestrial plants, animals, and freshwater aquatic species listed as endangered, threatened, and candidate species. NOAA Fisheries has lead responsibility under the ESA for listed marine taxa such as *Cetacea* (all whales and porpoises), *Pinnipedia* (Steller sea lions, Hawaiian monk seals, etc.), sea turtles, and anadromous fish (steelhead, coho salmon, etc). NOAA Fisheries is also the lead for the Marine Mammal Protection Act (1972) and Magnuson-Stevens Fishery Conservation and Management Act.

The federal, state, and CNPS categories for special status species are defined as follows:

- Federal endangered: Any species that is in danger of extinction throughout all or a significant portion of its range.
- Federal threatened: Any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.
- California endangered: Any species that is in danger of extinction throughout all or a significant portion of its range in the state.
- California threatened: Any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its state range.
- California rare (plants only): A native plant that, although not currently threatened with extinction, is present in small numbers throughout its range, such that it may become endangered if its present environment worsens.
- CNPS List 1A: Presumed extinct in California.

- CNPS List 1B: Rare or endangered in California and elsewhere.
- CNPS List 2: Rare or endangered in California, more common elsewhere.
- CNPS List 3: More information needed.
- CNPS List 4: Plants of limited distribution.

Assessment Methodology

Special Status Plants

Fire plays a role in the life history of many special status plant species by maintaining open habitat, encouraging reproduction, and affecting competing species. Fire may injure or kill individual plants while the effects on the species as a whole are beneficial because competition has been reduced or openings (i.e., habitat) created. Fire suppression activities can adversely affect these same species because of ground disturbance. Mechanical treatments can enhance habitat for special status plant species through removal of fuel loads and forest canopies, or can exacerbate problems through opening previously densely vegetated areas and allowing aggressive nonnative species to become established. Prescribed fires can be beneficial or detrimental, depending on the timing, frequency, and intensity of management-ignited fires. For example, detrimental effects can occur if fires are ignited outside the normal season or beyond the normal intensity to which the species is adapted. Keeping these factors in mind, the following parameters have been used to evaluate the consequences of the various alternatives on special status plants:

- The species affected and its degree of local, regional, national, and global rarity.
- The numbers of plants or proportion of the species range affected by the action.
- The response of the species to fire or disturbance (if known).

Type of Impact. The following terms and definitions apply:

Adverse: Would lead to loss or alteration of habitat, loss of individuals or populations of special status plants, or reduction in reproduction.

Beneficial: Would lead to increases in suitable habitat, an increase in areal extent or density of plants, or an increase in reproduction.

Duration of Impact. The following terms and definitions apply:

Short-term: Would immediately affect the population or species, but would have no long-term effects on population trends or species viability.

Long-term: Would lead to a loss in population or species viability – exhibited by a trend suggesting decline in overall species areal extent or abundance.

Intensity of Impact. The following terms and definitions apply:

Negligible: Imperceptible or not measurable (undetectable).

Minor: Small, measurable, perceptible, and localized, without the potential to increase if left alone.

Moderate: Apparent, measurable, and sufficient to cause a change in the resources (e.g., abundance, distribution, quantity, or quality). Less localized than a minor impact.

Major: Substantial, highly noticeable, and with the potential for landscape-scale effects and major irreversible population effects.

Special Status Wildlife

Like other wildlife species in the planning area, special status species have adapted to natural fire regimes. In many areas, however, a history of fire suppression has led to dense, overgrown stands, with high accumulations of forest fuels. This affects special status species by altering habitat and placing these species and their habitats at risk for a high-intensity, stand-replacement fire. In addition, stand-replacement fire could create unsuitable habitat conditions that would last for many years.

Fire control activities could also adversely affect special status species through direct disturbance of animals and habitats. Even management actions designed to benefit habitat, such as prescribed fire, can have inadvertent adverse effects on special status species. With these factors in mind, the following parameters have been used to evaluate the effects on special status animals of the various alternatives:

- The species affected and its degree of local, regional, national, and global rarity.
- The rarity of the genotype or subspecies, regionally, nationally, or globally.
- The numbers of animals or proportion of the species range affected by the action.
- The response of the species to fire or disturbance (if known) on a population or subpopulation level.

Type of Impact. The following terms and definitions apply:

Adverse: Likely to result in unnatural changes in the abundance or distribution of a special status species. This could occur through direct disturbance, mortality, or through destruction or alteration of habitat.

Beneficial: Likely to protect and/or restore the natural abundance and distribution of a special status species. This could occur through protection and restoration of structure, successional state, or distribution of habitat.

Duration of Impact. The following terms and definitions apply:

Short-term: Would result in immediate changes in the abundance and distribution of a special status species, but a return to the original condition would occur within two generations of that species.

Long-term: Would result in changes in the abundance and distribution of a special status species that persist for more than two generations of that species.

Intensity of Impact. The following terms and definitions apply:

Negligible: Would be imperceptible or unmeasurable (undetectable).

Minor: Would be slightly perceptible and localized in extent; without further actions, adverse impacts would reverse and the resource would recover.

Moderate: Would be readily measurable (apparent) and extend farther geographically than a minor impact; adverse impacts would eventually reverse and the resource would recover.

Major: Would be substantial, highly noticeable, and affecting a large geographic area; changes would be irreversible with or without active management.

Cultural Resources

Policies and Regulations

NPS Management Policies 2001 states that, "all cultural resource and natural resource values will be considered in defining specific treatment and management goals" (NPS 2000a). Furthermore, "The treatment of a cultural landscape will preserve significant physical attributes, biotic systems, and uses when those uses contribute to historical significance… Treatment decisions will consider both the natural and build characteristics and features of a landscape, the dynamics inherent in natural processes and continued use, and the concerns of traditionally associated peoples." Archeological resources are to be "managed in situ, unless the removal of artifacts or physical disturbance is justified by research, consultation, preservation, protection, or interpretive requirements" (NPS 2000a). They will be "maintained and preserved in a stable condition to prevent degradation and loss," and their condition is to be "documented, regularly monitored, and evaluated against initial baseline data."

Section 106 of the National Historic Preservation Act (NHPA) requires federal agencies to consider the effects of their actions on properties listed on, or eligible for inclusion in, the National Register of Historic Places, and to provide the Advisory Council on Historic Preservation with a reasonable opportunity to comment. To fulfill this requirement, consultation with the State Historic Preservation Officer was initiated on May 23, 2003. A programmatic agreement on the GGNRA FMP constituting Section 106 compliance is presently under development among GGNRA, the State Historic Preservation Officer, and the Advisory Council. The NPS also extended an opportunity for consultation with associated American Indian tribes and the public, to take into account the effects of the FMP on historic properties within the park. This programmatic agreement will be modeled upon a nationwide template

developed by the National Association of State Historic Preservation Officers, the Advisory Council, the Department of the Interior, and Department of Agriculture land management agencies.

Impact analysis for the FMP, as a whole, follows procedures as described in the regulations implementing the NHPA (36 CFR 800.4), and is consistent with the requirements of NEPA. These include procedures for identifying historic resources in the area of potential effect, weighing the effects of a proposed undertaking against those qualities that make the historic properties eligible for the National Register, applying the criteria of effect to determine the level of effect, and identifying ways to minimize those effects. Compliance with Section 106 for specific sites and fire management will be carried out on an individual basis according the stipulations of the programmatic agreement on the GGNRA FMP (Appendix J).

Assessment Methodology

This impact analysis methodology includes consideration of the same five categories of cultural resources described in Chapter 3, Affected Environment: archeological resources, cultural landscapes, structures, ethnographic resources, and museum objects.

Cultural resource impacts in this document are described in terminology consistent with the regulations of the Council on Environmental Quality and the Advisory Council for Historic Preservation and in compliance with the requirements of both NEPA and the NHPA.

Type of Impact

Impacts are considered either adverse or beneficial to historic properties when analyzed under NEPA. However, impact type is not viewed in this manner when conducting analysis under Section 106 of the NHPA. For the purposes of assessing effects on historic properties under the NHPA, effects are either adverse or not adverse. Effects under both NEPA and the NHPA are considered adverse when they diminish the significant characteristics of a historic property.

Duration of Impact

Impacts on historic properties could be of short-term, long-term, or permanent in duration. Analysis of the duration of impacts is required under NEPA, but is not required, and is usually not considered separately, in assessing effects under NHPA.

Intensity of Impact

The following terms and definitions apply:

Negligible: Impacts would be barely perceptible.

Minor: Impacts may be perceptible and noticeable, but would remain localized and confined to a single element or significant characteristic of a historic property (such as a single contributing element of a larger historic district).

Moderate: Impacts would be sufficient to cause a noticeable but not substantial change in significant characteristics of a historic property, but not sufficient to compromise its qualifications for the National Register.

Major: Impacts would result in substantial and highly noticeable changes in significant characteristics of a historic property leading to the compromising of its qualifications for the National Register.

Human Health and Safety

Policies and Regulations

As described in the policies and regulations discussion under "Air Quality" above, the 1977 Clean Air Act (CAA) mandates the protection of human health and the prevention of significant deterioration of air quality and establishes acceptable levels of emissions for a range of pollutants. The California Air Resources Board is charged with protecting air quality in the state and developing a State Implementation Plan (SIP) to interpret and enforce the emission standards set by the federal EPA. The Bay Area Air Quality Management District (BAAQMD) is the air management district charged with monitoring and implementing the CAA, including approvals for prescribed burning, in the nine-county Bay Area Air Basin.

According to Section 4.7.1 of the NPS Management Policies, the NPS has a responsibility to protect air quality under both the 1916 Organic Act and the Clean Air Act, both to protect scenic vistas and the visitor experience and to protect public health. Policies direct the superintendents to "make reasonable efforts to notify visitors and employees when air pollution concentrations within an area exceed the national or state air quality standards established to protect public health." (Please refer to the air quality methodology and assessment sections below for more information on air quality policies and regulations.) In considering the potential adverse effects of air emissions on public health, federal agencies are directed to consider the ambient air quality above the national ambient air quality standards (NAAQS) for $PM_{2.5}$ and PM_{10} as the principal indicator of adverse impacts (EPA 1998).

The highest priority for federal firefighting strategy, tactics, and policy is the protection of the lives and promotion of the safety of firefighters and the public. NPS Director's Order 18 (NPS 2003a) states that "…firefighter and public safety must be the first priority in all fire management activities." NPS Management Policies 2001 states that "all wildland fires would be effectively managed, considering resource values to be protected and firefighter and public safety…." and all actions taken involving wildland fire have as their overriding goal providing for firefighter and public safety (NPS 2000a). Firefighter worker safety and right to a safe work environment are protected by the Occupational Safety and Health Act of 1970 (29 USC 651 – 678; PL 91-5969).

In addition to indicating a public health risk, high levels of visible particulates can result in poor visibility and contribute to a traffic safety hazard. Section 4.4.5.3 of NPS Management Policies 2001 addresses herbicide use within the park. Herbicides are a subset of pesticides, which are defined by the Federal Insecticide, Fungicide and Rodenticide Act as any substance or mixture that is used in any manner to destroy, repel, or control the growth of any viral, microbial, plant, or animal pest. Fuel reduction projects

that involve removal of certain nonnative plant species, such as eucalyptus and black acacia, typically involve the use of herbicides to prevent resprouting of cut tree stumps. All proposals to use herbicides in the park must submit a Herbicide Use Request to the GGNRA integrated pest management (IPM) coordinator, who reviews the requests on a case-by-case basis. The proposals are judged on potential environmental effects, cost, staffing, and other considerations. The decision to use herbicides is based on a determination by the IPM coordinator that all other available options are either not acceptable or not feasible.

Assessment Methodology

Fire management activities and the potential for injury, illness, and other direct and indirect impacts are evaluated for their potential to affect the public, park staff, and fire personnel during implementation of fire management activities at GGNRA. The analysis includes the impacts of prescribed fire, suppression, wildland fire use, and mechanical treatment on the health and safety of the public, park staff, and fire personnel. The analysis also assesses the potential exposure of park visitors to high noise levels and impacts of FMP actions on the soundscape of the park.

Type of Impact

The following terms and definitions apply:

Beneficial: Would result in a reduction in human health and safety concerns or improve human health or safety.

Adverse: Would result in additional or exacerbated public health and safety concerns.

Duration of Impact

The following terms and definitions apply:

Long-term: Would have a permanent effect on human health and safety (e.g., contamination of a water source for domestic use would be a long-term impact).

Short-term: Would be temporary and/or intermittent and be associated with the implementation phase of fire management actions (e.g., safety concerns related to smoke from a prescribed burn).

Intensity of Impact

The following terms and definitions apply:

Negligible: Imperceptible or undetectable effect upon the public, staff, or fire personnel.

Minor: Slightly detectable or localized effect upon the public, staff, or fire personnel.

Moderate: Clearly detectable impact that could have a readily perceivable effect on public health and safety and extend over a sizeable area.

Major: Substantial, highly noticeable impact and/or an impact that would extend over a large area of the park. The impact would initiate or resolve a significant public or firefighter safety or health hazard.

Visitor Use and Visitor Experience

The assessment of effects on visitor use and the visitor experience focuses on several aspects of this broad topic that were raised as potential issues during the scoping period for the FMP. The alternatives are assessed for potential to affect viewsheds and the aesthetic aspect of park landscapes, causes changes to public access patterns to parklands, and cause changes to the park soundscape.

Policies and Regulations

NPS Management Policies 2001 makes numerous references to aesthetics and visitor experience as central issues in the considerations that go into resource protection and park planning. Section 1.4.6 describes the "park resources and values" that are subject to the NPS "no impairment" standard, including a park's scenery, scenic features, natural visibility (both in daytime and at night), natural landscapes, natural soundscapes, and smells, which all contribute to the visitor experience. Important national park values also include the opportunity "to experience enjoyment of the above [listed] resources, to the extent that can be done without impairing any of them" (NPS 2000a).

NPS Management Policies 2001 Section 4.7.1, Air Quality, states that the NPS "has a responsibility to protect air quality under both the 1916 Organic Act and the Clean Air Act (CAA)." This responsibility would be reflected in the FMP by discussions of potential effect of FMP actions on air quality, air quality effects on public health and air quality effects on the visitor experience. NPS Management Policies 2001 directs the NPS to "perpetuate the best possible air quality in parks to (1) preserve natural resources and systems; (2) preserve cultural resources; and (3) sustain visitor enjoyment, human health, and scenic vistas" (NPS 2000a).

As discussed under "Impacts on Air Quality" below, scenic resources are extremely sensitive to air pollution. Even a very small amount of fine particulate matter in the air can affect the ability to perceive colors, contrast, texture, and form of features, landmarks, and panoramas. Visual air quality is very important to park visitors. Specific vistas are often mentioned in legislation or congressional reports concerning the establishment of an NPS unit. Protection of scenic resources is addressed in Director's Order 77, Natural Resource Management (NPS 1991).

One of the potential effects on visitor access and visitor experience is the need for park staff to close public access to work areas or burn areas due to unsafe conditions during or just following implementation of FMP actions. NPS Management Policies 2001 addresses the need for occasional temporary closures or delays in public passage in order to ensure public safety. Section 8.2.2.1, Management of Recreation Use, advises superintendents to "use their discretionary authority to impose local restrictions, public use limits, and closures, and designate areas for a specific use or activity (see 36 CFR 1.5). Any restriction of appropriate recreational uses will be limited to what is necessary to protect park resources and values, to promote visitor safety and enjoyment, or to meet park management needs" (NPS 2000a).

Director's Order 47 addresses the problem of excessive/inappropriate levels of noise in the park (NPS 2000a). It directs park managers to measure baseline acoustic conditions, determine which existing or proposed human-made sounds are consistent with park purposes, set acoustic management goals and objectives based on those purposes, and determine which noise sources are affecting the park and need to be addressed by management. It also requires park managers to evaluate and address self-generated noise such as FMP actions, and constructively engage with those responsible for other noise sources that affect parks to explore what can be done to better protect parks.

NPS Management Policies 2001, Section 4.9, Soundscape Management, addresses the generation of noise in conjunction with NPS actions in and adjacent to parks:

> "The Service will monitor human activities that generate noise that adversely affects park soundscapes, including noise caused by mechanical or electronic devices. The Service will take action to prevent or minimize all noise that, through frequency, magnitude, or duration, adversely affects the natural soundscape or other park resources or values, or that exceeds levels that have been identified as being acceptable to, or appropriate for, visitor uses at the sites being monitored."

Assessment Methodology

The effects of each alternative were evaluated by analyzing potential impacts on the physical components affected and, using best professional judgment and information from relevant studies, assessing how the change may be experienced by the visitor. The following aspects of the proposed actions under each alternative were assessed:

- **Visual Aspects.** Would fire management actions be readily visible from views within the park or important views of the park? In which areas of the park would landscape modification be most noticeable or intrusive? Could the action affect a scenic vista along a road or a scenic view? Are there any ways in which the effects of the fire management action could be made less visible or restoration accelerated?

- **Visitor Experience and Access.** Would the project intrude on a visitor's park experience? Would the project curtail visitor access to parts of the park? For how long? Are there ways to provide an alternative experience during the closure?

- **Noise.** Would the sounds of the fire management action be readily perceptible within the park? From adjacent properties? In which areas of the park would the sound be most noticeable or intrusive? Would the sounds be continuous or intermittent? Are there any ways in which the effects of the sound could be mitigated or lessened?

As these questions indicate, the assessment will examine effects on the current aesthetic environment, soundscape, and visitor use patterns as well as the effect of modifications to the current condition. While aesthetic considerations can be quantitatively monitored, it is difficult to address potential changes to views. This is perhaps the most subjective of all the environmental impact assessment topics. Unfortunately, there is no objective, numerical standard or threshold that can be employed to state what

constitutes an aesthetic effect. As is often the case in NPS management, judgment is necessary. Effects on aesthetics also must be analyzed in the context of cumulative effects of a number of different activities or actions, both within and outside parks. What could be insignificant alone (for example, one helicopter trip near a popular overlook) could become significant and highly intrusive in the context of other actions (one helicopter trip in combination with nine diesel buses and a nearby, audible, and clearly visible vegetation management project).

Visitor experience and aesthetic appreciation are tied closely to actions influencing natural resources. The enhancement or degradation of air quality, vegetation, and cultural resources has a corresponding effect on the quality of the visitor experience. Impacts on these issue areas are assessed under separate headings.

Type of Impact

The following terms and definitions apply:

Beneficial: Would enhance visitor appreciation of the natural landscape, the quality of visitor experience, or the visual quality of the landscape, or promote the native soundscape.

Adverse: Would degrade visitor appreciation of the natural landscape, the quality of visitor experience, or the visual quality of the landscape, or disrupt or intrude upon the native soundscape.

Duration of Impact

The following terms and definitions apply:

Short-term: Action would be temporary, with a duration restricted to the finite time period of project implementation.

Long-term: Action would be associated with a programmatic change or would continue indefinitely, or viewshed disturbance would be readily apparent for more than two years.

Intensity of Impact

The following terms and definitions apply:

Negligible: Would result in little or no noticeable change in visitor experience.

Minor: Would be detectable but localized within a topographically confined area; would result in changes in visitor experience when visitors or park neighbors are close to the project site but would not appreciably alter important landscape or soundscape characteristics.

Moderate: Would be readily noticeable, and/or change the visual character, soundscape, or visitor experience of larger vistas of the park or be seen from the park by modifying one or more secondary features of a vista, but not the keystone features of the vista.

Major: Would be highly noticeable, intrusive to the visitor experience, and/or change the character of the landscape or soundscape in significantly large areas, and/or change

important vistas seen from the park or of the park by modifying the keystone features of the vista.

Park Operations

Policies and Regulations

Like most federal agencies, the NPS relies on federal appropriations to fund its core activities, although there is increasing use of alternative revenue sources, such as fees, to supplement operations. The NPS requests direct Congressional funding and reports on the other federal revenue sources through an annual budget document submitted to Congress entitled "Budget Justifications," or more popularly called the "Green Book."

Financial resources currently available to GGNRA include a base operating budget of approximately $21.4 million, which represents about 230 FTE (full-time equivalents, or one person for a full year). This work force is supplemented by over 5 million total volunteer hours each year.

In addition to the above operational funding, the park receives fee revenues and special national park project and program funding for specific maintenance, natural and cultural resources, and other projects. In addition, the park receives approximately $539,000 annually in FirePro and Wildland Interface funding for hazardous fuel reduction and fire prevention activities.

Assessment Methodology

Impacts were evaluated by assessing changes that would be required to meet the operational requirements outlined in each of the alternatives. Relative costs were generated using staff estimates of funding and labor required to implement these actions. These effects were compared to existing operations, staffing, and funding at the park.

Existing staffing levels were inventoried and assessments were made of current park operations. In addition, professional judgments by individuals who are most knowledgeable about various activities were used to anticipate the operational changes that would be needed under each action alternative. Estimates were made of the personnel required to:

- Provide education and information services to the public regarding fire activities;
- Research, plan, develop, and ensure regulatory compliance of proposed FMP actions;
- Conduct mechanical treatments to reduce hazardous fuels;
- Conduct prescribed fires to preserve natural and cultural resources and reduce hazardous fuels; and
- Monitor the effects of FMP actions.

The estimates of operational changes were compared to existing staffing levels. It should also be noted that precise impacts on staffing and funding are difficult to project until site-specific projects are

proposed. Thus, the estimates are intended to provide a general description of potential effects, considering the variability within the range of possible operational scenarios.

The discussions of impacts address operations that would be new, undergo major change, or show susceptibility to increases or decreases in operational activity.

Type of Impact

The following terms and definitions apply:

Adverse: Would represent an increase in operating costs.

Beneficial: Would represent a decrease in operating costs and operational efficiency.

Duration of Impact

The following terms and definitions apply:

Short-term: Would last only until all actions are completed.

Long-term: Would have a permanent effect on operations.

Intensity of Impact

The following terms and definitions apply:

Negligible: There would not be a measurable difference in costs from existing levels.

Minor: Additions or reductions in cost would be less than 15 percent of existing levels.

Moderate: Additions or reductions in cost would be between 16 and 30 percent of existing levels.

Major: Additions or reductions in cost would be more than 30 percent of existing levels.

Socioeconomics

Policies and Regulations

The NPS regulations for NEPA state that "social and economic impacts are considered an integral part of the human environment in the NPS and should be analyzed in any NEPA document where they are affected. Socioeconomic impacts include those to minority and low-income communities as specified in the Environmental Justice Executive Order (EO 12898; Feb. 11, 1994)." This executive order – Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations – requires all federal agencies to incorporate environmental justice into their missions by identifying and addressing disproportionately high and adverse human health or environmental effects of their programs and policies on minorities and low-income populations and communities.

This section examines the socioeconomic environment that might be affected by the fire management activities in and around the park under the three alternatives. Choosing different alternatives may affect the flow of dollars through the local economy.

Impacts of Fire Management Operations

Fire programs affect the economy in several ways. The direct impacts are associated with the core fire management payroll and the amount of local goods and services purchased directly by the department. An increase in staffing would be expected to have a net positive benefit to the area since most of the money paid to fire staff is spent locally in the form of housing, food, services, and local purchases. Spending by the fire management department on supplies and private contracted services also funnels dollars directly into the economy. Any increase or decrease in the core fire management budget spending would thus have some positive or negative effect on the local economy. The extent of the impact is determined, in part, by the amount of spending by the GGNRA fire management unit compared to the overall economy.

Suppression of major fires also affects the local economy. Increases in fire staffing and private contracts to restore burned areas can have a positive net impact on the local economy, while property damage and loss of visitation can have adverse short-term impacts.

Visitor Spending

In addition to the direct economic impact associated with GGNRA's staffing and spending in the area, the indirect impact associated with spending by park visitors is also factored into the analysis. This indirect benefit results from spending on food, lodging, fees, gifts, and other retail items. Modifications in fire operations for prescribed burns and mechanical treatments would have a negative economic impact if park visitation rates and associated spending were reduced by either shortened or rescheduled plans due to road closures, park or facility closures, smoke, or noise.

Fire suppression activities also may affect visitation rates and associated tourist spending depending upon the size, location, and extent of an unplanned fire. To date, most of the temporary area closures that have occurred at GGNRA have resulted from wildland fires and not fuel reduction projects. The loss of spending by visitors in the local economy from larger wildfires is partially offset by increased spending on temporary fire personnel and requirements for structural repairs or replacement, utility repairs, slope rehabilitation, and other activities required to restore the area.

Assessment Methodology

In addition to any possible effects on minority and low-income populations and communities, alternatives were evaluated for their potential direct impacts, such as property loss, and indirect economic effects, such as from park closures, on the regional economy and resident/tourist population as a whole.

Type of Impact

The following terms and definitions apply:

Adverse: Would degrade or otherwise negatively alter the characteristics of the existing environment, as the relate to local communities (including minority and low-income), visitor population, regional economics, and concessionaires and contractors.

Beneficial: Would improve on characteristics of the existing social and economic environments, as they relate to local communities (including minority and low-income), visitor population, regional economies, and concessionaires and contractors.

Duration of Impact

The following terms and definitions apply:

Short-term: Temporary and typically transitional impacts associated with implementation of an action.

Long-term: Permanent impacts on the social and economic environments.

Intensity of Impact

The following terms and definitions apply:

Negligible: Undetectable and expected to have no discernible effect on the social and economic environment.

Minor: Slightly detectable and not expected to have an overall effect on the character of the social and economic environment.

Moderate: Detectable and could have the potential to initiate an increasing influence on the social and economic environment.

Major: Substantial, highly noticeable influences on the social and economic environments, and could be expected to alter those environments permanently.

4.2 Environmental Impact Analysis

Impacts on the Physical Environment

Impacts on Watershed Processes: Soils, Hydrology, Water Quality, and Aquatic Habitat

Analysis

As described in Chapter 3, fires are natural events that maintain healthy watersheds, but they can also impair watershed processes. Watershed attributes such as water yield, peak flows, sediment yield, nutrient yield, stream system response, and water quality can be affected by fire management activities. These impacts will vary depending on the extent of activity in the watershed, the type of soils and slopes within the watershed, and the proximity of the activity to streams.

Fire management activities can affect soil resources through disruptions to the soil horizon, erosion, compaction, and changes to soil properties. These impacts on soils can in turn affect the hydrology of the watershed by increasing sedimentation, changing the surface flow, and impairing water quality. These impacts will have an effect on the quality of the aquatic habitat within the watershed.

Impacts on Soils

Disruption of the soil horizon can occur from most fire management activities, including the creation of fire lines during suppression and prescribed burning and the removal of plants and their roots during mechanical removal. These activities will disturb or bury the upper soil layers that are rich in nutrients, organisms, and seeds and potentially impair the watershed processes.

Erosion can be accelerated by wildland fires, prescribed burning, and fuel reduction projects that remove the overlying vegetation and duff from surface soils and leave soils exposed to wind and water. Erosion selectively removes nutrients, organic materials, and fine particles from topsoil, reducing soil productivity. A decrease in productivity can have a consequent effect on the density, vigor, and range of plant species that will survive or repopulate an area, and can also create conditions under which nonnative plant species are better competitors than native vegetation. Bare ground can remain bare for a longer period of time on steeper slopes, or when soils are susceptible to becoming hydrophobic. Clay-rich soils subject to very high fire intensity may fuse at the soil surface, decreasing porosity, slowing infiltration of water, and increasing the rate of surface soil erosion.

The severity and duration of accelerated erosion depend on several factors, including soil texture, slope, recovery time of protective cover, the amount of residual litter and duff, and post-burn precipitation intensity. On a larger scale, the transportation of soils through erosion can result in changes to the landscape such as the formation of gullies or the sedimentation of ponds and wetlands and clogging of stream channels.

Compaction can likewise lead to increased surface runoff and result in erosion. Activities that compact the soil, such as use of heavy equipment, will decrease the capacity of the soil to infiltrate water and therefore create downstream effects.

Changes in soil characteristics occur during wildfires, and to a lesser extent with cooler prescribed burns. Hydrophobicity can result when fire increases soil temperatures, causing the volatilization of hydrophobic materials into the soil. A hot wildfire, such as those that may occur in forested areas of the park or where fuels have built up, may create hydrophobicity deeper in these soils. However, the impermeable layer that develops in the upper soil horizon may have beneficial impacts by controlling the loss of moisture to evaporation. This maintains soil moisture and encourages seedling establishment.

Plant nutrients may also be lost through volatilization during a fire. Fires can release important plant nutrients, such as phosphate, sulfate, and nitrogen, as organic matter is volatilized through combustion both into the air and forced down into the soil. In a hot wildfire, the loss would be greater than in a prescribed burn, as the effects would extend deeper into the soil and would not leave much organic matter on the surface. Conversely, ash deposits from the fires themselves can increase the amount of nutrients available to plants post-fire, especially nitrogen, and can spur rapid plant growth following the fire. Extremely hot fires may also kill beneficial fungi and bacteria that live in soils or wildlife that tunnel near the surface.

Impacts on Watersheds and Water Quality

Water yield in a watershed can increase after a fire or mechanical thinning due to a decrease in both transpiration and water infiltration. Infiltration can be reduced several ways, from increased compaction by heavy equipment to the formation of hydrophobic soils by intense fires. The removal of litter and debris by either method will also lead to decreased infiltration and increased surface flow. The combined effect of these changes can temporarily increase water yield and overland flow, leading to increased peak flows for months or years afterwards. This could exacerbate levels of soil erosion; increase sedimentation levels in streams, wetlands, and other water bodies; and degrade water quality. Increased erosion could also cause changes to surface hydrology, including overland, undirected flow; channelized surface water flow; and flow to drainage infrastructure.

Sediment yields can increase after fires or tree removal due to this increased overland water flow and the associated erosion. Sediments can wash into streams and scour the bank and streambed, or settle on the stream bottom and cover important rock or cobble habitat. This problem becomes more severe if the streamside vegetation has also been burned, since the banks then become even less stable. If a fire is particularly hot, woody debris that helped stabilize the channel may be consumed, increasing water velocity and streambank erosion. Extremely high levels of sediments can injure fish or other aquatic organisms by clogging their gills or obscuring the presence of food.

Nutrient yields increase after fires from the breakdown of plant materials. Some materials will volatize into the atmosphere, while the remainder is left as ash in readily mobile forms on the soil surface. When nitrogen and other nutrients found in ash make their way into the aquatic ecosystem, they can increase production of algae and aquatic plants. Decay of this excessive biomass can deplete water of oxygen and lead to fish kills.

Stream system response, both physical and biological, can change as the result of fire management activities. A stream channel may initially aggrade and widen after a fire in response to higher peak flows

of water, increased sediment, and loss of riparian vegetation. As vegetation becomes reestablished, the channel usually returns to pre-fire size within several years.

Water quality can be affected by sediment and nutrient input as well as inputs from other fire management activities. For example, herbicides used in fuel reduction and wetting agents or saltwater used during suppression actions can degrade water quality.

Most of the impacts on soils have a direct effect on the hydrology of a watershed. Fire management actions that accelerate levels of soil erosion can increase sedimentation levels in streams, watersheds, and other water bodies and degrade water quality. Bare, hydrophobic, or compacted soil can increase the level of surface water flow, create scour, and decrease the amount of infiltration to groundwater. Water quality can be affected by increased sedimentation as well as contamination by saltwater, herbicides used for fuel reduction, and fire-retardant agents. Most fire retardants contain fertilizer type compounds such as ammonia and nitrogen and could cause changes in pristine terrestrial and aquatic ecosystems. Additionally, ammonia itself can be quite toxic in aquatic habitats. Some retardants also contain preservatives that release cyanide that can be fatal to aquatic life.

Impacts on Aquatic Habitat

These water quality impacts can lead to impairment of aquatic habitats within a watershed. Aquatic organisms rely on specialized habitats within streams or other water bodies that can be blanketed by a pulse of sediment from upstream. Runoff of herbicides into water bodies could kill the algae at the base of the food chain and lead to food shortages in the small invertebrates that depend on it. High levels of saltwater dropped into a water body could increase the salinity to such an extent that sensitive organisms could be affected. Lastly, the input of fire retardant into a stream could prove fatal for aquatic organisms.

Beneficial Effects of Fire Management Activities

Many of the impacts discussed above are part of natural watershed processes that can create beneficial effects under normal conditions. Disturbances such as erosion and sedimentation can deliver nutrients and woody debris to aquatic habitats and maintain complex and productive ecosystems (Bisson et al. 2003). Modifications to normal watershed conditions, such as the amount of vegetative cover, can alter the natural processes of infiltration and evapotranspiration and lead to a disruption in the water balance. For example, studies from Southeast Asia and Australia have demonstrated rapid reduction of water yield and soil moisture after the planting of eucalyptus trees (Samra et al. 2001). Conversely, actions that remove vegetation can lead to an increase in water yield by decreasing evapotranspiration (loss of water by evaporation from the soil and by transpiration from the plants). In one post-fire study, a 5-percent reduction in evapotranspiration resulted in a 30-percent increase in the annual runoff in a watershed (Zwolinski, 2000). This could be a beneficial effect in a watershed where current flow levels are below historic levels.

Fires can have other beneficial impacts on watersheds. Riparian vegetation can recover quickly from fires, and research indicates that the closer a plant is to the water table, the higher the potential for regeneration after a fire event (Russell and McBride 2001). This suggests that riparian areas are very resilient to fires and could benefit from the mosaic of habitat and regeneration of growth that is created.

Likewise, soil productivity, which is dependent on organic matter, recovers quickly in burned areas that are left undisturbed (Beschta et al. 2004). The short-term decrease in soil productivity in the uplands of a watershed would be accompanied by an increase in nutrients in the downstream aquatic ecosystem (Bisson et al. 2003). Provided that these processes occur in watersheds where aquatic species are healthy and habitats remain productive, diverse, and interconnected, the effects on the ecosystem would be beneficial.

Overall, fire management actions such as prescribed burning and mechanical removal of nonnative vegetation can be an important component of watershed management, in combination with other actions that improve the natural processes and connections. In addition, fire management activities would limit the potential for catastrophic fire that could burn along the entire vertical gradient in the watershed, creating extensive hydrophobic soils resulting in increased sediment loads to watersheds. In the long term, fire management activities would have beneficial effects on watersheds by reducing the severe impacts of a catastrophic fire that could extensively burn an entire watershed.

Actions Common to All Alternatives

Wildland-Urban Interface Initiative

Projects conducted under the Wildland-Urban Interface Initiative would be subject to project review to ensure that they would minimize adverse impact on soils, erosion, or water resources.

Defensible Space/Vegetation Clearing Around Buildings

Clearing around structures could leave soils unvegetated and/or disturbed and vulnerable to erosion. Ensuring that these activities do not denude the soil, or incorporating erosion control measures, would avoid effects on soil or water resources.

Roadside Fuel Reduction

As described in Chapter 2, maintenance standards for existing fire roads would be developed by park staff and would include guidance on grading and vegetation removal. Maintenance standards would include such actions as outsloping of roads to prevent rill and gully erosion. In addition, unnecessary fire roads may be eliminated, and others may be reconfigured or rerouted to address erosion problems. These actions would be conducted to reduce erosion potential, and should have a beneficial impact.

Suppression

Wildland fire and the suppression and restoration actions that follow wildland fire all have the potential to affect watershed resources within the park. Depending on the intensity and duration of a wildland fire, immediate and long-term changes in soil properties and watershed processes can occur.

Suppression activities can cause soil compaction, profile mixing, erosion, contamination, and overheating of soils. Manual or mechanized earthmoving to create firebreaks and roads or smother burning materials can mix the layers of the soil horizon and bury the fertile topsoil layer and the native seedbed within the topsoil, reducing the success of post-fire native plant revegetation. Removal of covering vegetation and uprooting of plants and tree roots by heavy equipment expose disturbed soils to erosion by water and wind.

Saltwater used for suppression can create an adverse effect on the soil chemistry. The duration and intensity of this effect would depend on the site conditions, the amount of saltwater applied for suppression, and the rainfall and runoff patterns following the fire. Likewise, use of fire retardants for suppression can introduce harmful substances to an aquatic ecosystem.

Based on the average size of historic wildfires in GGNRA annually, the impacts created by suppression activities would create no more than short-term, minor adverse effects in any one watershed. In combination with the applicable mitigation measures listed in Chapter 2, impacts on watersheds from suppression activities would be adverse, short-term, and negligible or minor.

Treatment of Muir Woods FMU

Fire management projects at Muir Woods National Monument would include prescribed burning and mechanical removal. These actions could affect watershed resources by causing erosion, soil compaction, and sedimentation into water bodies. The acreage of proposed projects in Muir Woods National Monument (part of the Redwood Creek watershed) are small in scale compared to the size of the watershed. Therefore, the impact on watershed resources would be minor. The beneficial impacts of these activities would be to restore the natural hydrologic and nutrient cycles in the watershed. Combined with the applicable mitigation measures listed in Chapter 2, the impact of fire management activities at Muir Woods National Monument on watershed resources would be beneficial, long-term, and moderate.

Treatment of San Francisco County Project Area

See “Defensible Space Clearing Around Structures” above. Mechanical removal of nonnative evergreen trees could have short-term adverse impacts on soil and soil erosion. For tree removal actions in areas with highly erosive soils or steep slopes, tree stumps would be left in place and cut as close to ground surface as feasible.

Public Information and Fire Education Programs

Fire information and education actions proposed for all alternatives would have no beneficial or adverse effects on soil or water resources in the planning area.

Fire Cache

For the purposes of this document, it is assumed that the activities performed at the fire cache(s) would be consistent with the surrounding resource objectives and would be done in accordance with best management practices (BMPs) for soil and water quality protection. For example, vehicle washing would be done on a wash rack designed to prevent contamination of surface waters.

Fire Effects Monitoring

Monitoring plans would be reviewed to ensure that fire-related monitoring has no adverse effect on soils or water resources. In general, monitoring and evaluation would benefit watershed resources as it would enable managers to make corrective actions if necessary.

Alternative A

Mechanical Fuel Reduction

Mechanical fuel reduction in Alternative A would occur in nonnative forests along the Wildland Urban Interface. These activities could lead to watershed effects such as erosion and soil compaction and create adverse, short-term, and minor impacts. However, the removal of nonnative trees from within a watershed could help improve the hydrological cycle by restoring natural infiltration and evaporation processes. Combined with the applicable mitigation measures listed in Chapter 2, mechanical treatments in Alternative A would have a beneficial, long-term, and moderate effect on watershed processes.

Pile Burning

Most mechanical removal projects would include pile burning. The piles would be small in size and create very localized compaction and hydrophobic soil. These impacts would be minor on a watershed scale and would not affect soil or hydrology resources.

Prescribed Fire

Prescribed burning under Alternative A would be focused in Marin County and would largely burn grassland and coastal scrub. Prescribed burning activities such as fire line creation and the burn itself could cause watershed impacts such as disruption of the soil horizon and soil properties, erosion, sedimentation, and changes to hydrology. If large-scale burns are planned for one watershed, the burn could potentially disrupt a large enough percentage of the watershed to cause a moderate impact. However, the maximum acreage to be burned under Alternative A during any one year is 100 acres (in Marin County), and the burning is unlikely to occur within one watershed. This acreage is less than 5 percent of most watersheds in Marin County. Given the small scale of the prescribed burning activities, Alternative A would have an adverse, short-term, and minor impact on soil and water quality within a watershed.

Positive effects from burning could be realized in the restoration of watershed processes such as infiltration and evaporation. In addition, the return of a more natural fire interval would prevent fuel buildup and decrease the potential for a catastrophic fire that could have a major impact on watershed processes.

With the inclusion of the applicable mitigation measures listed in Chapter 2, the prescribed burning activities in Alternative A would have beneficial, long-term, moderate impacts on watershed processes.

Research

Alternative A would include an element of research into the effects of fire on vegetation. Part of the research could be to determine the effects of fire on soil, hydrology, and aquatic resources in the watershed. This research would have a beneficial impact, as the results could inform future decision making that prevents future impacts on the watershed. Since these research burns would be synonymous with the burns described above, the possible adverse impacts would be the same.

Cumulative Impacts

Under Alternative A, FMP actions would be occurring in conjunction with the implementation period of several NPS and community projects, particularly in Marin County. For example, several current and proposed projects and plans have components that could affect the 8.9-square-mile Redwood Creek watershed, including:

- The Big Lagoon Restoration Project at Muir Beach, which will explore alternatives for restoring or enhancing ecological processes near the mouth of Redwood Creek, reduce flooding of local infrastructure, restore the creek channel and wetlands, reconfigure facilities to improve hydrologic processes, and provide an visitor access and a range of visitor experiences.

- Ongoing NPS habitat restoration actions along Redwood Creek, including removal of nonnative plants and planting of native plant species.

- Recent floodplain restoration along Redwood Creek on the Banducci property and the continuation of the effort under Phase II improvements.

- Recent work to reduce flooding potential at Pacific Way leading to Muir Beach.

- Roadway improvements and parking lot reconfiguration to reduce resource damage and promote sustainable resource management at Muir Woods National Monument and Muir Beach as part of the Comprehensive Transportation Management Plan.

- Possible improvements to the Coastal Trail in the vicinity of Muir Beach as part of the Trails Forever Project.

These projects should be considered when developing implementation strategies for the various project areas described in the FMP. The combined impacts of unrelated projects and fire management activities within a watershed should not exceed the threshold for minor impacts (i.e., slightly perceptible and localized, without the potential to expand if left alone). For example, fire management planning should ensure that prescribed burning or mechanical treatments create only negligible impacts in the upper reaches of a watershed during the timeframe when a concurrent project is being implemented downstream.

Other watersheds in Marin and San Mateo counties containing NPS lands could be affected by the implementation of projects funded by the Wildland-Urban Interface Initiative on private lands, and by habitat restoration or nonnative plant removal projects or fire management actions conducted by Marin County Fire Department or other local land management agencies. Fire management in the San Francisco project area could affect the drainage of Lobos Creek, which is shared with land managed by the Presidio Trust. PRNS and GGNRA both have lands within the larger watershed draining to Bolinas Lagoon.

To avoid adverse cumulative impacts on the Redwood Creek watershed and other park watersheds in Marin and San Mateo counties, fire management actions should be scheduled, sited, and coordinated with other actions that contribute to stream sedimentation. Consideration should be given to any transportation,

trail improvement, maintenance, habitat restoration, or other project that disturbs the soil or would otherwise affect the hydrology or water quality within a watershed.

Conclusion

Fuel reduction achieved by fire management actions under Alternative A would benefit watershed conditions and hydrologic processes by reducing the risk of catastrophic fire and returning fire intervals. These effects overall would be beneficial, long-term, and moderate. Effects of prescribed fire on water quality due to increased erosion would be adverse, minor, and short-term until vegetation is reestablished. Impacts from soil disturbance by mechanical treatments would be adverse, short-term, and negligible to minor. The effects of the removal of nonnative evergreen forest on the watershed effects within the areas treated by mechanical means would be beneficial, long-term, and minor to moderate.

Suppression activities would adversely affect soils due to compaction and ground disturbance. Because the number of acres burned by wildfires each year remains quite low, impacts on watersheds would be adverse, short-term, and minor.

In sum, actions implemented under this alternative would have adverse, short-term, and minor effects on water quality. In the long term, the actions of Alternative A would have a beneficial, long-term, minor-to-moderate effect in restoring the natural hydrology of the area.

A large-scale unplanned fire could have adverse, potentially long-term, and major impacts on both water quality and features of watersheds, including riparian zones and watercourses.

Impairment

Because the actions under this alternative would have only short-term and minor adverse effects, no impairment of soil and water resources within park watersheds is expected.

Alternative B

Mechanical Fuel Reduction

Alternative B includes mainly mechanical fuel reduction throughout the park, particularly in the WUI FMU. Although the total acreage of projects per year would be greater than in Alternative A, the impacts would not change significantly. With the implementation of the mitigation measures described for Alternative A, the overall impacts on watersheds from mechanical removal under Alternative B would be beneficial, long-term, and minor.

Pile Burning

Impacts would be the same as under Alternative A.

Prescribed Fire

In Alternative B, prescribed burning would occur in the Muir Woods FMU and the Park Interior FMU, with a maximum of 120 acres per year throughout the park. This level of impact is similar to Alternative A. With the implementation of the mitigation measures described for Alternative A, the effects of

prescribed fire on watersheds under Alternative B would be adverse, short-term, and minor for soil and water quality, and beneficial, long-term, and moderate for overall watershed health.

Research

Impacts would be the same as under Alternative A.

Cumulative Impacts

Under Alternative B, nearly twice as much mechanical fuel reduction could occur as compared to Alternative A. The acreage of prescribed burning is nearly identical in the two alternatives. The majority of mechanical fuel reduction under Alternative B would occur on parklands in Marin County close to the park boundary with residential development. Fuels in the interface zone are predominately nonnative evergreen forest and nonnative shrubs such as French or Scotch broom and fennel. Where tree stumps are left in place, surface soil disturbance is limited to compaction or disturbance from skidders or vehicles used to transport cut timber.

Most of the projects included in the consideration of cumulative effects are well away from the WUI zone on the eastern edge of GGNRA lands. Restoration efforts and nonnative plant removal undertaken by park stewards are often focused in the interior of the park, where efforts to contain the spread of nonnative plants can be more effective than on the park's interface. Cumulative impacts from prescribed burning projects would be essentially the same as described for Alternative A and would incorporate the same mitigation measures that require consideration of fire management actions on a watershed scale with emphasis on erosion control.

Cumulatively, effects from other actions when combined with the effects from Alternative B would be short-term, minor, and adverse due to the potential for an increase in the level of erosion from prescribed burning. Many of the projects considered for the cumulative impact assessment, such as the Big Lagoon project and the floodplain expansion on the Banducci property, are focused on resolving long-standing resource problems and enhancing ecological function. Long-term, moderate beneficial impacts would accrue throughout the affected watersheds through the reduced potential for a catastrophic fire to occur in conjunction with the resource benefits gained from other concurrent projects.

Conclusion

Fire management actions under Alternative B, especially the prescribed burns in the park interior, would improve the long-term watershed conditions and natural hydrology by reducing the risk of catastrophic fire and returning fire intervals. These effects overall would be beneficial, long-term, and moderate. Effects of prescribed fire on water quality due to increased erosion would be adverse, minor, and short-term until vegetation is reestablished. Impacts from soil disturbance due to mechanical treatments would be adverse, short-term, and negligible to minor. However, the watershed effects within the areas treated by mechanical means would be beneficial, long-term, and minor to moderate.

The same types of watershed impacts would result from typical wildland fires in the park each year. Suppression activities would affect soils due to compaction and ground disturbance. Mitigation Measure FMP-6 describes the requirements for resource advisors to work with firefighters to minimize the

potential effect of suppression efforts. Mitigation Measure FMP-7 requires burned area rehabilitation teams to be requested for any multiday wildland fire incident. Because the number of acres burned by wildfires each year would remain quite low and a rehabilitation plan would be required to stabilize burned areas and reduce soil erosion and potential damage to adjacent properties, impacts on watersheds would be adverse, short-term, and minor.

A large-scale unplanned fire could have adverse, potentially long-term, and major impacts on both water quality and features of watersheds, including riparian zones and watercourses.

Impairment

Because the actions under this alternative would have at worst short-term, minor adverse effects on watershed resources, no long-term impairment of watersheds would result from this alternative.

Alternative C

Mechanical Fuel Reduction

Alternative C includes more mechanical fuel reduction in Marin County, with the same acreages in San Francisco and San Mateo County as Alternative B. The increased acreage in Marin is located in the park interior areas. Although the total acreage of projects per year would be greater than under Alternatives A and B, the impacts would not be significantly different. With the implementation of the mitigation measures described for Alternative A, the impacts on watershed resources of mechanical removal under Alternative C would be adverse, short-term, and minor for soil and water quality, and beneficial, long-term, and moderate for overall watershed health.

Pile Burning

Impacts would be the same as under Alternative A.

Prescribed Fire

Under Alternative C, prescribed burning would occur mainly in the Park Interior FMU, with a limited amount in the Wildland Urban Interface and Muir Woods FMUs. A maximum of 320 acres per year would be burned throughout the park. While this is an increase in acreage from Alternatives A and B, the intensity of impact would not exceed minor. The size of even the largest anticipated prescribed burn would not be enough to affect more than a small fraction of any watershed. However, the beneficial impacts of prescribed burns would increase with the increased acreage.

With the implementation of the mitigation measures described for Alternative A, the effects of prescribed fire on watersheds under Alternative C would be adverse, short-term, and minor for soil and water quality, and beneficial, long-term, and moderate for overall watershed health.

Research

The impacts of this alternative would be similar to Alternatives A and B. However, the beneficial impacts could be greater due to the opportunity for more research burns.

Cumulative Impacts

Under Alternative C, there is potential for cumulative effects on soils and water resources to occur if fire management actions and construction projects proposed for the same watershed are timed to occur simultaneously. With the application of mitigation measures that address the potential effect on the watershed scale and the project scale, potential project effects would be short-term, minor, and adverse, as in Alternative A. Under Alternative C, long-term, moderate beneficial impacts on the watershed would be achieved by reducing the potential for a catastrophic fire through a faster rate of reduction at key areas of high fuel loading, compared to Alternative A.

Conclusion

Fire management actions under Alternative C, in particular prescribed fire, would improve watershed conditions and natural hydrology by reducing the risk of catastrophic fire and returning more natural fire intervals. This alternative would have the greatest effect on the park's watersheds, and would be beneficial, long-term, and moderate. Effects of prescribed fire on water quality due to increased erosion would be adverse, minor, and short-term until vegetation is reestablished. Impacts from soil disturbance due to mechanical treatments would be adverse, short-term, and negligible to minor. However, the watershed effects within the areas treated by mechanical means would be beneficial, long-term, and minor to moderate.

The same types of watershed impacts would result from typical wildland fires in the park each year. Suppression activities would affect soils due to compaction and ground disturbance. Because the number of acres burned by wildfires each year would remain quite low, impacts on watersheds would be adverse, short-term, and minor.

A large-scale unplanned fire could have adverse, potentially long-term, and major impacts on both water quality and features of watersheds, including riparian zones and watercourses.

Impairment

Because the actions under this alternative would have at worst short-term, minor adverse effects, no impairment of park watershed resources is expected.

Impacts on Air Quality

Analysis

The smoke management techniques listed in Chapter 2, Section 2.7 "Mitigation Measures," will apply to all the proposed FMP alternatives. These and additional strategies are described in the 2002 U.S. Department of Agriculture General Technical Report, Wildland Fire in Ecosystem, Effects of Fire on Air Quality and in the National Wildfire Coordinating Group's Fire Use Working Team publication "The Smoke Management Guide for Prescribed and Wildland Fire: 2001 Edition." Prescribed burns, pile burning, research burning, and flexible suppression strategy actions would be conducted incorporating these mitigation measures to lessen the effects of smoke and other emissions on human health, ecological health, air quality, and visibility. (Note: The effects of air emissions, such as particulates from smoke, on

respiration and roadway visibility are addressed in this FEIS under "Impacts on Human Health and Safety" below.)

Actions Common to All Alternatives

Wildland-Urban Interface Initiative

GGNRA has experience with implementation of the federal Wildland-Urban Interface Initiative program for the past three years. The NPS funds community projects by local fire agencies, local land management agencies, or homeowners' associations for treatment of fire hazard areas within the wildland urban interface. Projects on the federal side of the interface are the responsibility of national parks. The NPS also grants funding to community groups, other land management agencies, and local fire departments for fuel reduction projects on private lands within the interface zone with the national park. These projects are not directly managed by the NPS and will be addressed as part of the cumulative impact assessment.

To date, all projects funded by the Wildland-Urban Interface Initiative within GGNRA have been sited in Marin County. Though this program has also funded public education projects at GGNRA, the majority of the funding has been for mechanical fuel reduction projects near the federal interface with residential communities in Marin County. There are instances where projects involved pile burning to dispose of debris from felled nonnative trees or pruned vegetation. In most cases, it is more cost-effective to chip and distribute woody debris onsite. Where inaccessibility to a chipper or resource constraints or other factors limit or prohibit chips from being broadcast at the site, burn piles are an effective solution to reduce debris. Where projects involve trees infested with pitch pine canker or SOD, the prescribed treatment is to leave all material onsite and avoid transportation. If there is too much debris to leave onsite, burn piles would be used to reduce the amount of downed fuel at the site. For these projects, the construction, ignition, and monitoring of pile burning will be supervised by NPS staff or the Marin County Fire Department and necessary burn approval will be attained from BAAQMD. Occasionally, burn piles may not be practical when residential development is near a park fuel reduction project site and nuisance smoke and soot impacts on property would be difficult to avoid. Experience over the last three years indicates that two to three projects per year may include pile burning. For Alternative A, it is estimated that approximately 25 burn piles would be completed each year. This amount of burn piles is included as part of the project description under each alternative. Emissions are estimated in Table 4-4.

Table 4-4: Emissions from Pile Burning for Projects Funded by Wildland-Urban Interface Initiative under Alternative A

Number of Burn Piles	Emissions (pounds per year)					
	PM_{10}	$PM_{2.5}$	VOC (as methane)	CO	NO_x	SO_2
25	0.03	0.02	0.01	0.3	0.0	0.0

Source: NPS Air Resources Division 2004.

Notes:

PM_{10} = suspended particulate, $PM_{2.5}$ = fine particulate matter, VOC = volatile organic compounds (methane), CO = carbon monoxide, NOx = nitrogen oxides, SO_2 = sulfur dioxide

Defensible Space/Vegetation Clearing Around Structures

Similar to roadway fuel reduction projects, emissions from equipment use during defensible space clearing around structures are considered insignificant in comparison to overall emissions generated by fire management actions and wildland fire, and would have a negligible effect on air quality. Prescribed burning and pile burning are not associated with clearing around structures. These actions would have a short-term, negligible adverse effect on regional air quality and no effect on visibility.

Roadside Fuel Reduction

Roadway fuel reduction primarily involves equipment, including trucks, chippers, chain saws, and brushcutters. Normally, cut vegetation is chipped and redistributed onsite. In certain cases along fire roads, some pile burning may be needed to reduce excess fuels that should not be left onsite. The emissions from pile burning are included in the overall emissions calculations for each alternative. The emissions that would be generated by equipment and vehicle use have been determined to have a negligible effect on air quality according to the NPS Air Resources Division. Roadway fuel reduction would make a short-term, negligible adverse contribution to regional air quality; there would be no effect on visibility.

Suppression

Smoke from unplanned ignitions is a complex mixture of carbon, tars, liquids, and gases. The major pollutants from fire that are monitored by BAAQMD under the Clean Air Act are particulates (PM_{10} and $PM_{2.5}$), volatile organic compounds (VOC), carbon monoxide (CO), and nitrogen oxides (NOx). NOx is produced in relatively small quantities compared to the other pollutants (see Chapter 3, Section 3.3, discussion under “Air Quality”).

As described in the air quality methodology discussion above, the First Order Fire Effects Model (FOFEM) is used to generate the amounts of air emissions representative of a typical annual occurrence of wildland fire in GGNRA. The vegetation types, number of occurrences, and size of occurrences were provided by GGNRA fire management staff (Naar 2004). In order to derive realistic emission totals, the inputs into FOFEM for wildland fire are based on a rough estimate of the occurrence of wildland fire in the principal vegetation types.

The annual wildfire scenario used as the baseline for analysis in this EIS is estimated at 39 acres of annual wildland fire (Naar 2004). Of the 39 total acres, 12 acres (31 percent) contain coastal scrub vegetation, 25 acres contain grasslands (64 percent) and the remaining 2 acres (5 percent) are forested areas. The estimated emissions produced annually by the current level of wildland fire occurring in GGNRA is the same under the three FMP alternatives.

Table 4-5 shows the output of the FOFEM fuel model types and emission factors used to derive emissions for wildland and prescribed fire in grasslands, coastal scrub, and Douglas-fir forest. As there is little difference in the amount and type of emissions produced by prescribed burning in grasslands or coastal scrub compared to wildland fire in grasslands or coastal scrub, the same emission factors are used for both types of fire in these two plant communities. To estimate emissions from wildland fire and prescribed fire in Douglas-fir forest, the same fuel model type was used but specific factors associated with that model

type, such as an increased involvement of the forest canopy, were modified to represent a wildfire and produce more realistic emission levels for this higher-intensity and higher-emission burn.

Table 4-5: FOFEM Emissions Factors for Wildfire, Prescribed Burning, and Pile Burning

FOFEM Inputs				Emission Factors (pounds per year per acre burned)					
GGNRA Cover Type	**FOFEM Surrogate**	**Code**	**Fire Type**	**PM_{10}**	**$PM_{2.5}$**	**VOC**	**CO**	**NOx**	**SO_2**
Coastal Scrub	Cean	SRM 208	Prescribed	190	161	49	404	198	62
Grass	Valley Grassland	SRM 215	Prescribed	11	9	3	23	12	4
Native Forest	Pacific Douglas-fir	SAF 229	Prescribed	2863	2445	1480	32319	24	114
Coastal Scrub	Cean	SRM 208	Wild	190	161	49	404	198	62
Grass	Valley Grassland	SRM 215	Wild	11	9	3	23	12	4
Native Forest	Pacific Douglas-fir	SAF 229	Wild	3640	3085	1867	40836	31	145
Nonnative Trees	Pacific Douglas-fir	SRM 229	Pile Burning	2660	2254	1329	28606	162	145

Source: NPS Air Resources Division 2004.
Notes:
FOFEM = First Order Fire Effects Model, SRM = Society for Range Management, SAF = Society of American Foresters, PM_{10} = suspended particulate, $PM_{2.5}$ = fine particulate matter, VOC = volatile organic compounds (methane), CO = carbon monoxide, NOx = nitrogen oxides, SO_2 = sulfur dioxide

During suppression of unplanned ignitions, transport and fire vehicles such as trucks, engines, and water tenders would be onsite to patrol and stand by on alert at fires. Equipment such as chain saws and graders could be used to clear fuels, provide access, or transport firefighters. Heavy equipment, fire engines, and water tenders would be used to fight the fire. The level of emissions generated by equipment and vehicles during wildland fire suppression is considered a negligible contribution to air emissions relative to the emissions in the wildfire smoke.

The potential annual air emissions from wildland fire in GGNRA are shown in Table 4-6. Emissions generated by this level of wildland fire would have a long-term, negligible, adverse effect on levels of SO, $PM_{10,}$ CO, and NO_x and a long-term, minor, adverse effect on ozone (represented by VOC) levels in the Bay Area Air Basin.

Smoke dispersion during a wildfire would vary depending on weather conditions, elevation of the fire, wind direction, fuel type, and accessibility of the area for firefighting equipment. A fire in blue gum eucalyptus could burn with tremendous intensity and spread extremely fast, producing local winds from rapid convection and heating. Under these conditions, drifting burning material, such as the eucalyptus bark, has great potential to ignite spot fires further spreading the fire (Boyd 1997). Active suppression can affect smoke generation and visibility as a cooling, slower fire produces more smoke than a rapidly burning fire. However, smoke management is typically a secondary concern to overall suppression and containment. Suppression actions are geared to control, containment, and confinement and, while cooling a fire, suppression may actually increase smoke generation over the short term while curtailing the

continued combustion of new fuels and additional smoke. There are too many variables for each fire and each suppression effort to make a definitive conclusion about the effect of suppression on smoke generation, regional air quality, and visibility. As the fire is the primary cause of air emissions, smoke and the pollutants generated as a result of the actual suppression efforts on the part of firefighters can be considered secondary and a minor consequence of the suppression effort. Suppression actions would generally have a short-term, moderate beneficial effect on regional air quality but would not reduce the potential for a large-scale catastrophic wildfire to occur in the future with more severe air quality impacts.

Table 4-6: Projected Annual Emissions for Wildland Fire in GGNRA

County / Cover Type	Wildland Fire Acreage	Emissions					
		PM_{10}	$PM_{2.5}$	VOC (as methane)	CO	NOx	SO2
Marin							
Coastal scrub	10	1,900	1,610	490	4,040	1,980	620
Grass	20	220	180	60	460	240	80
Native forest	2	7,280	6,170	3,734	81,672	62	290
Subtotal		**9,400**	**7,960**	**4,284**	**86,172**	**2,282**	**990**
San Francisco	**0**	**0**	**0**	**0**	**0**	**0**	**0**
San Mateo							
Coastal scrub	2	380	322	98	808	396	124
Grass	5	55	45	15	115	60	20
Native forest	0	0	0	0	0	0	0
Subtotal		**435**	**367**	**113**	**923**	**456**	**144**
Total Acreage	**39**						
Total Wildland Fire Emissions (pounds per year)		**9,835**	**8,327**	**4,397**	**87,095**	**2,738**	**1,134**
Total Wildland Fire Emissions (tons per year)		**4.9**	**4.2**	**2.2**	**43.5**	**1.4**	**0.6**

Source: GGNRA Fire Management Office and NPS Air Resources Division 2004.

Notes:

PM_{10} = suspended particulate, $PM_{2.5}$ = fine particulate matter, VOC = volatile organic compounds (methane), CO = carbon monoxide, NOx = nitrogen oxides, SO_2 = sulfur dioxide

Treatment of Muir Woods FMU

FOFEM is used to estimate the amounts of air emissions generated by the up to 50 acres of understory burning annually in the Muir Woods FMU in burn units of 0.5 to 50 acres. The fuel type used to generate emissions for understory is Pacific Douglas-fir with characteristics indicating low rate of forest canopy involved by the burning. Proposed FMP actions for this FMU also include approximately 5 acres of mechanical treatment, including providing defensible space around structures and preparing burn units for prescribed fires.

The proposed strategy for the Muir Woods FMU is the same under the three FMP alternatives. However, under each alternative, the 50 acres of prescribed burning in the understory of the redwood/Douglas-fir forest at Muir Woods differs in relative importance to the overall program for fuel reduction, in the degree of activity it represents, and the percent of total emissions it produces (see Tables 4-7 and 4-8).

Table 4-7: Relative Importance of Muir Woods Prescribed Burning (PB) Under Each Alternative

Alternative	Muir Woods PB as % of Total Acreage of PB	Muir Woods PB as % of Total Acreage of PB in Native Forest	Muir Woods PB as % of Total $PM_{2.5}$ Emissions	Muir Woods PB as % of Total VOC Emissions	Muir Woods PB as % of Total NOx Emissions
A	45%	100%	96%	98%	16%
B	42%	77%	74%	75%	16%
C	16%	71%	66%	69%	6%

Source: NPS Air Resources Division 2004.
Notes:
$PM_{2.5}$ = fine particulate matter, VOC = volatile organic compounds (methane), NOx = nitrogen oxides

Table 4-8: Projected Annual Emissions from Prescribed Burning in Douglas-Fir Forested Understory at Muir Woods FMU

Action Type	Acres	Emissions (tons per year)					
		PM_{10}	$PM_{2.5}$	VOC	CO	NOx	SO_2
Annual Emissions, Prescribed Fire	50	71.6	61.1	37.0	808.0	0.6	2.9

Source: NPS Air Resources Division 2004.
Notes:
PM_{10} = suspended particulate, $PM_{2.5}$ = fine particulate matter, VOC = volatile organic compounds (methane), CO = carbon monoxide, NOx = nitrogen oxides, SO_2 = sulfur dioxide

Table 4-8 shows the estimated levels of emissions produced by understory burning in the Muir Woods FMU at the annual maximum of 50 acres per year. Given the amount of preparation through mechanical treatment required prior to burning in a mature forest, restrictions on allowable burn days, demands for implementation of competing fire management projects elsewhere in the park, variable coastal climate, and visitation levels at Muir Woods National Monument, NPS fire staff may not be able to complete 50 acres per year or successfully schedule a prescribed burn in the redwood/Douglas-fir forest once each year. In actual practice, understory burning may be accomplished by a series of smaller burns scheduled over several consecutive years. (Estimated daily emissions under this scenario are shown in Table 4-9.) In this respect, the annual emissions estimated for Muir Woods FMU projects, which represents the largest generator of particulate matter and volatile organic compound (VOC) emissions annually for each alternative, may be overstating actual emissions produced by the three alternatives. Nonetheless, the estimate of emissions is a useful conservative estimate to compare the relative impacts for full implementation of the three alternatives.

Table 4-9: Projected Daily Emissions from Prescribed Burning in Douglas-Fir Forested Understory at Muir Woods FMU

Action Type	Total Acres	Burns per Year	Emissions per Burn (tons per day)					
Prescribed Burn Totals	**50 acres**	**3 burns total**	**PM_{10}**	**$PM_{2.5}$**	**VOC**	**CO**	**NO_x**	**SO_2**
Typical Forested Understory Prescribed Burn	16.6	3	23.7	20.3	12.3	268.2	0.2	0.9

Source: NPS Air Resources Division and GGNRA Fire Management Office 2004.
Notes:
PM_{10} = suspended particulate, $PM_{2.5}$ = fine particulate matter, VOC = volatile organic compounds (methane), CO = carbon monoxide, NO_x = nitrogen oxides, SO_2 = sulfur dioxide

The total annual emissions of VOC, for which the air basin is in nonattainment status, is less than 50 tons per year, a level below the *de minimus* threshold and therefore not requiring a determination of conformity with the SIP. The No Action alternative would generate approximately 39.9 tons per year including the 39 acres of wildland fire annually. This level of emissions would have a long-term, moderate adverse effect on air quality, according to the methodology used when assessing those emissions with "nonattainment" status in the air basin. NOx emissions generated would be less than one ton per year and would have a long-term, negligible adverse effect.

Smoke management plans proposed by the NPS for prescribed burning in the Muir Woods FMU or other areas of the park are submitted to BAAQMD for approval at least 30 days before the planned burn day. The approval for ignition by BAAQMD is based on the objective of maintaining Bay Area Air Basin air pollutant emissions within the NAAQS shown in Table 3-4. BAAQMD's decision to permit ignition of prescribed burns is supported by the best available meteorology and forecasting at the time of ignition and allows BAAQMD to coordinate the location and amount of emissions generated simultaneously by prescribed burning in one air basin.

Generally, smoke effects from prescribed burning last only as long as the fire management action. Smoke behavior varies with the amount and type of fuel burned. In areas such as the redwood/Douglas-fir forests at Muir Woods National Monument, the fuel load consists of decades of accumulated duff. Because it tends to smolder, duff produces relatively more particulates than burning vegetation does. In grassland and coastal scrub, a higher percentage of fuels are light fuels that burn in the flaming phase, resulting in a significantly lower rate of emissions and smoke generation.

Dense smoke would likely occur in the vicinity closest to wildfire operations. Unhealthful concentrations of smoke would be most likely to affect fire personnel immediately adjacent to the fire. (See discussion under "Impacts on Human Health and Safety" below.) Most smoke plumes from fire suppression operations disperse at middle to upper elevations and, occasionally, under unfavorable wind conditions, into the more heavily populated areas of Marin County.

Under prevailing wind conditions, smoke generation would generally be confined to the interior of the Marin Headlands, Muir Woods National Monument, Muir Woods Road, and Panoramic Highway, with

short-term, minor adverse effects on the residential areas along Panoramic Highway. Ideal conditions for prescribed burning would push smoke west toward the ocean. Less ideal would be winds or drift to the southwest toward Muir Beach, Highway 1, and the Muir Beach community. However, if burn prescription conditions are met, prescribed burning could proceed under prevailing wind conditions, with potential short-term, minor-to-moderate adverse smoke effects on unincorporated areas of Mill Valley, Marin City, or Sausalito once or twice a year. Under offshore conditions, there could be a short-term, minor, adverse effect on visibility at Highway 1, Muir Beach, and the Muir Beach community

Treatment of San Francisco County Project Area

Fuel reduction projects within San Francisco parklands would involve (1) mechanical fuel reduction projects, primarily along the open space/residential interface where nonnative vegetation has created a fire hazard, and (2) research burns that are strictly limited in size and focus on resource enhancement objectives. Emissions from equipment use and from small research prescribed burn would have negligible effects on air quality. No pile burning is proposed for the San Francisco project area. Actions in the San Francisco project area would have a short-term, negligible adverse effect on regional air quality and no effect on visibility.

Public Information and Fire Education Programs

The public information and education program would be used to notify the public and visitors in advance of prescribed burning and pile burning projects. The program would also be the primary means used to explain the role of prescribed burning in promoting ecosystem health and restoration of the role of fire to the extent possible. In the immediate vicinity of proposed burning, the program would be used to identify any at-risk members of the public in advance of burning and discuss ways to protect their health if smoke drift affects the area or their neighborhood. The program would have no effect on regional air quality or visibility.

Fire Cache

The relocation of the fire cache to one facility would not affect regional air quality or visibility.

Fire Effects Monitoring

Implementation of the fire behavior monitoring program would have no effect on regional air quality or visibility.

Alternative A

Under Alternative A, the No Action alternative, a maximum of 110 acres of prescribed burning, 100 acres of mechanical treatment and limited pile burning (25 burn piles) could occur annually.

All prescribed burning at GGNRA has been, and would continue to be, planned and performed under the auspices of the BAAQMD Smoke Management Program. Prior to igniting a prescribed fire, GGNRA fire management staff must submit a smoke management plan to the BAAQMD Smoke Management Program and obtain meteorological approval to burn from that program. It is the responsibility of BAAQMD to coordinate the number of fires burning in one area. BAAQMD's objective is to ensure that

annual emissions from fire management actions implemented under the GGNRA FMP do not exceed state or federal standards.

Mechanical Fuel Reduction

As discussed earlier, emissions from mechanical treatments generated by equipment used to remove, process, or control vegetation are considered to be insignificant by the NPS Air Resources Division in relation to emissions generated by combustion, and have a negligible contribution to emission levels. For this reason, the low emission levels generated by equipment are not calculated as part of the impact assessment. Mechanical fuel reduction would have a short-term, negligible effect on regional air quality and visibility.

Pile Burning

Emission levels generated by pile burning under Alternative A are shown in Table 4-10. Burning of 25 piles would occur on one to three separate days depending on whether the woody debris was collected at one project site or at several. All pile burning would be coordinated with BAAQMD and a smoke management plan and burn plan would be submitted at least 30 days in advance for BAAQMD approval. Pile burning under Alternative A would have a short-term, negligible-to-minor adverse effect on regional air quality and visibility.

Prescribed Burning

As described earlier, FOFEM is used to estimate the amounts of air emissions that would be generated by the acreage of prescribed burning and number of pile burns proposed under Alternative A. In order to derive realistic emission totals, the inputs into FOFEM are based on the characteristics present at sites in GGNRA that could be proposed for prescribed burning in the future. The total area of the series of the burn sites modeled for each alternative is equivalent to the permissible acreage for prescribed burning annually under that alternative – for example, 110 acres under Alternative A. The vegetation type modeled is based on an estimate of the potential composition of the actual burn sites – roughly 27 percent grassland, 27 percent shrublands, and 45 percent forest understory. This estimate translates into 30 acres of grasslands, 30 acres of shrublands, and 50 acres of understory burns conducted primarily in redwood/Douglas-fir forest in Muir Woods National Monument.

All prescribed burns proposed by GGNRA must be approved for ignition by BAAQMD with the objective of maintaining Bay Area Air Basin air pollutant emissions within the NAAQS shown in Table 3-4. BAAQMD's decision to permit ignition of prescribed burns is supported by the best available meteorology and forecasting at the time of ignition and allows BAAQMD to coordinate the location and amount of emissions generated simultaneously by prescribed burning in one air basin.

Table 4-10: Projected Annual and Daily Emissions for Alternative A

ANNUAL EMISSIONS – TONS PER YEAR

Action Type	Area	Emissions (tons per year)					
		PM_{10}	$PM_{2.5}$	VOC	CO	NO_x	SO_2
Prescribed Fire: Grassland and Scrub	60 acres	3.0	2.6	0.8	6.4	3.2	1.0
Prescribed Fire: Forested Understory	50 acres	71.6	61.1	37.0	808.0	0.6	2.9
Pile Burning	25 burn piles	0.03	0.02	0.01	0.30	0.00	0.00
Annual Emissions From NPS Prescribed Fire		**74.6**	**63.7**	**37.8**	**814.7**	**3.8**	**3.9**
Estimated Annual Occurrence of Wildfire	39 acres	4.7	4.0	2.1	43.1	1.1	0.5
Total All FMP Projects – Alternative A		**79.3**	**67.7**	**39.9**	**857.8**	**4.9**	**4.4**

DAILY EMISSIONS –TONS PER DAY (per burn)

Action Type	Total Acres	Burns per Year	Emissions (tons per day)					
Prescribed Burn Totals	**110**	**7 burns total**	PM_{10}	$PM_{2.5}$	VOC	CO	NO_x	SO_2
Emissions – Typical Prescribed Burn in Grassland	30	2	0.1	0.1	0.0	0.2	0.1	0.0
Emissions – Typical Prescribed Burn in Coastal Scrub	30	2	1.4	1.2	0.4	3.0	1.5	0.5
Emissions – Typical Prescribed Burn in Forested Understory	50	3	23.9	20.4	12.3	269.3	0.2	1.0

Source: NPS Air Resources Division 2004.

Notes:

PM_{10} = suspended particulate, $PM_{2.5}$ = fine particulate matter, VOC = volatile organic compounds (methane), CO = carbon monoxide, NOx = nitrogen oxides, SO_2 = sulfur dioxide

Generally, air quality throughout GGNRA is very good due to prevailing winds and proximity to the Golden Gate and marine influences. Air quality can become degraded when the east Pacific high pressure system becomes displaced, typically in late summer and early fall when major atmospheric systems undergo a seasonal change. The result can be a general haze in the air basin, significantly impairing visibility (Sullivan et al. 2001).

The behavior of a smoke plume from a prescribed fire, including the direction and elevation of the plume and resulting concentrations at ground level, is highly dependent on elevation and dynamic meteorological conditions at the time. Higher-elevation winds tend to better dilute and disperse smoke at lower concentrations. High-level winds may transport dispersed smoke particles long distances. Complex

geography and weather patterns complicate the ability to predict exactly the quantity and destination of smoke particles in the plume. Fall and early winter generally have climatic conditions least favorable to smoke dispersion, while spring and summer generally have better conditions for dispersing smoke. Within GGNRA, prescribed burning is normally scheduled from early fall through late spring with specific meteorological requirements in the burn prescription for conditions with lower potential for loss of control of the fire and smoke dispersal. As discussed below under "Impacts on Human Health and Safety" and "Impacts on Visitor Use and Visitor Experience," care would be taken to site prescribed burns sufficiently distant from residential development and principal roads to avoid direct effects from smoke. GGNRA staff would inform park neighbors and visitors about the scope of prescribed burns and provide roadway assistance if burning results in visibility hazards on adjacent roadways.

Perceptible visibility impacts could occur during the prescribed burn but would be limited to primarily to the project site in the park and to the smoke plume following the prevailing winds; normally the smoke would disperse quickly during the course of the day. Prescribed burning under Alternative A could contribute 37.8 tons of VOC (as methane) and 3.8 tons of NOx annually to the Bay Area Air Basin. These pollutants are precursors to ozone; the air basin is currently in nonattainment for ozone though in attainment status for NOx. The level of VOCs would have a long-term, moderate adverse effect on air basin air quality; particulates (PM_{10} and $PM_{2.5}$) generated by full implementation of Alternative A would have a minor adverse effect recurring annually as additional areas of the park are treated to reduce fuels. The level of NOx and SO_2 would be considered a long-term, negligible adverse effect on air quality (see air quality methodology discussion at the beginning of this section).

Research

Impacts on air quality from the use of prescribed burning for research purposes are included in the overall assessment of effect of the full 110 acres of prescribed burning permitted annually under Alternative A. There is no effect on air quality from research burns distinct from the effect of the larger prescribed burning program. Research burns in the San Francisco project area would be of a very limited size, focusing on resource enhancement objectives in either grassland or coastal scrub and contributing negligible emissions annually.

Cumulative Impacts

Assessment of cumulative impacts for the FMP alternatives includes the effects of pile burning conducted to reduce debris from fuel reduction projects funded by the Wildland-Urban Interface Initiative occurring outside the park boundaries, and other prescribed burning occurring annually in western Marin County. Projects listed in Appendix C were considered in the cumulative impact assessment for air quality but, with the exception of the PRNS FMP, the projects listed would not generate significant emissions compared to those generated by prescribed burning and would have a relatively negligible effect.

Experience over the past three years of implementation of the Wildland-Urban Interface Initiative in the community shows that approximately 25 burn piles can be expected annually from community fuel reduction projects funded by this program. Additional projects considered in the cumulative scenario for air quality impacts (and included in Table 4-11) include the annual fuel reduction program conducted by the Marin County Fire Department, which is estimated at roughly 50 acres of prescribed burning and 50

burn piles annually (Julin 2004). These burns may be conducted on private property or on lands managed by California State Parks, the Marin County Open Space District, or the Marin Municipal Water District. Of the Marin County Fire Department prescribed burns, half of the vegetation affected would be on grasslands with nonnative broom species and half conducted in mixed evergreen forest understory.

Cumulative impacts also include prescribed burning conducted under the recently adopted PRNS FMP, which permits a total of 2,000 acres of prescribed burning annually. The amount of pile burning was not calculated for the PRNS assessment.

Table 4-11 below combines the total emissions levels for Alternative A projects from Table 4-10 with the additional emissions from Wildland-Urban Interface Initiative community projects and Marin County Fire Department burning that could cumulatively contribute to air quality impacts. Nearly all potential emissions would occur in Marin County, as compared to San Mateo County. (Under Alternative A, 91 percent of prescribed burning would occur in Marin County). The cumulative effect of GGNRA and Marin County Fire Department actions would be a long-term, moderate, adverse cumulative impact on ozone and PM_{10} levels, a minor long-term effect on $PM_{2.5}$ levels, and negligible effects on nitrogen oxide and sulfur dioxide levels in the air basin.

Table 4-11: Alternative A Annual Cumulative Air Emissions

Project Type	Acres	Fire Emissions (tons per year)					
		PM_{10}	**$PM_{2.5}$**	**VOC**	**CO**	**NOx**	**SO_2**
Total All FMP Projects Alternative A	110-acre PB 25 burn piles 39-acre wildland fire	**79.3**	**67.7**	**39.9**	**857.8**	**4.9**	**4.3**
Pile Burning for Community Projects Funded by Wildland-Urban Interface Initiative	25 burn piles	0.03	0.02	0.01	0.3	0	0
Total GGNRA Actions		**79.33**	**67.72**	**39.91**	**858.1**	**4.9**	**4.3**
Typical MCFD Annual Actions*	50 burn piles 50-acre PB	35.96	30.75	18.53	404.9	0.5	1.5
Total Annual Actions by GGNRA and MCFD		**115.3**	**98.5**	**58.4**	**1,263.0**	**5.4**	**5.8**
PRNS FMP Implementation	Up to 2,000-acre PB	241.3	205	101.3	1801.7	51.5	NG
Total Cumulative Annual Smoke Emissions		**356.6**	**303.5**	**159.7**	**3064.7**	**56.9**	**NG**

Source: PRNS Draft FMP 2004, NPS Air Resources Division and Kent Julin, Ph. D., County Forester, Marin County Fire Department, pers. comm.

Notes:

*Marin County Fire Department (MCFD) actions are meant to be representative of averaged estimated annual accomplishments.

PM_{10} = suspended particulate, $PM_{2.5}$ = fine particulate matter, VOC = volatile organic compounds (methane), CO = carbon monoxide, NOx = nitrogen oxides, SO_2 = sulfur dioxide, NG = not given, PB = prescribed burn

The PRNS FMP assessed the effects of prescribed burning on 2,000 acres annually and 1,500 acres of mechanical treatment. When the emission levels predicted for the selected alternative from the PRNS FMP EIS are added, impact levels of particulate matter and NOx move into the category of a long-term, major adverse cumulative effect on PM_{10}, $PM_{2.5}$, and VOC emission levels. The level of NOx emissions would have a long-term, minor effect and SO_2 emissions would remain at a negligible level of effect.

In the SIP for carbon monoxide, BAAQMD includes an annual level of prescribed burning for vegetation management within the maintenance area as a factor that contributes to annual CO emissions (D. Kolozsvari, BAAQMD, pers. comm.). In developing the SIP, BAAQMD estimated that some 34, 588 tons of woody fuels could be burned annually for non-agricultural, vegetation, and forest management practices in the Bay Area Air Basin. The assumptions of the SIP for CO, provided by BAAQMD, allow 37% of the annual total, or 12,800 tons of woody material, to be allocated to actions in Marin County and 17%, or 5,880 tons, in San Mateo County. This totals 18,680 tons for the two counties (Douglas Kolozsvari, BAAQMD, email 8/24/05).

Using the assumptions provided by BAAQMD, the maximum tonnage of prescribed burning allowed annually under the cumulative scenario, including Alternative A, would represent roughly 80% of the total annual tonnage factored into the SIP for CO for this type of prescribed burning in these two counties. The assumptions include factors for prescribed burning conducted on acreage with heavy fuels, acreage with light fuels, and include maximum allowable acreages on an annual basis from projects by GGNRA, Point Reyes National Seashore (PRNS), local fire agencies, and other land management agencies operating in the two counties.

As a contributor to the cumulative scenario, the park's proposed prescribed burning of the vegetation types at GGNRA under Alternative A would permit the burning of roughly 1,000 tons of vegetation annually; the SIP's full cumulative scenario accounts for approximately 15,000 tons heavy and light fuels annually. The majority of the tonnage included in the cumulative impact assessment can be attributed to the PRNS FMP, which proposes a cap of 2,000 acres of prescribed burning annually (in contrast to the cap of 110 acres under Alternative A of this EIS). With tonnage for the cumulative scenario calculated at 20% less than assumed for Marin and San Mateo counties under the SIP, and the probability that PRNS would not achieve 2000 acres per year of prescribed burning, the NPS believes that prescribed burning emissions under Alternative A are included in the SIP for CO and that no further conformity analysis is warranted.

All prescribed burning at PRNS and GGNRA would continue to be planned and performed under the auspices of BAAQMD's Regulation 5 governing Open Burning, which functions as the air district's smoke management plan. Since 2001, each air district in California must have an individual smoke management plan that meets state and federal requirements as directed by the Federal Interim Air Quality Policy on Wildland and Prescribed Fires. In conformance with Regulation 5 and prior to igniting a prescribed fire, NPS fire management staff must submit a smoke management plan to BAAQMD and must obtain meteorological approval to burn from BAAQMD. It is the responsibility of BAAQMD to coordinate the numbers of fires burning in one area in relation to ambient air quality. The oversight of BAAQMD would ensure that annual emissions from fire management actions implemented under the

PRNS FMP do not exceed state or federal standards. This oversight and the requirement to obtain BAAQMD approval for each individual prescribed burn, plus the availability of the mitigation measures to minimize the effects of prescribed burning, would reduce the level of effect on particulates and NOx to a long-term, moderate adverse cumulative effect.

Other projects and planning efforts listed in Appendix C would not generate nor significantly reduce emission levels on a scale that would be comparable to emissions generated by burning. Both the Comprehensive Transportation Management Plan for Parklands in Southwest Marin County and the Marin Headlands/Fort Baker Roadway Improvement and Transportation Management Plan are anticipated to include alternatives that would produce a slight reduction in vehicle emissions when fully implemented. This level of reduction in ambient air quality would not significantly reduce the effect of prescribed burning under Alternative A.

Conclusion

The largest source of air emissions is prescribed burning of understory fuels in the Douglas-fir/redwood forest in the Muir Woods FMU. This action is considered critical to the success of the FMP and is proposed as common to all alternatives. Understory burning in Muir Woods was initiated under the 1993 FMP and is the primary element held over from the original fire management plan. Under Alternative A, full implementation of prescribed burning in the Muir Woods FMU represents 96 percent of annual emissions while prescribed burning in 60 acres of grassland and coastal scrub vegetation generates the remaining 4 percent of annual emissions. Muir Woods FMU emissions would be generated in 1 to 3 prescribed burns annually depending on available opportunities for burn days, amount of pre-burn mechanical treatment needed to prepare a site for burning, competing demands on staffing and budgeting, and maintenance of prescription conditions through the burn day. (Changes in weather often result in early termination of burning or unsuccessful combustion when conditions are too wet.) The annual target of 50 acres of understory burning per year in each successive year can be considered as a worst-case scenario for air pollution generation under Alternative A with the exception of the occurrence of a catastrophic wildland fire. The intent of full implementation of Alternative A is to reduce the potential of a large-scale wildland fire and its consequent high levels of air emissions.

Alternative A would have a long-term negligible adverse effect on levels of NOx and SO_2, a long-term minor adverse effect on levels of particulates, and a long-term moderate adverse effect on levels of VOCs. Emission levels can be modified with the application of appropriate strategies from among the mitigation measures in consultation with BAAQMD.

The primary contributor to cumulative impacts in this portion of the air basin would be the full implementation of the approved PRNS FMP. Other similar actions in western Marin produce approximately half of the annual emissions estimated for GGNRA. Full implementation of the PRNS FMP and all other actions could produce more than twice the particulates generated by GGNRA and other sources annually (see Table 4-11). In comparison, a large-scale catastrophic wildland fire, such as the 1995 Vision Fire in Inverness Park in western Marin County, could produce nearly 85 times the amount

of particulates (PM_{10}) as Alternative A and nearly 20 times the particulates generated by cumulative projects shown in Table 4-11 (NPS 2004a)[1].

Mitigating the cumulative impact on air quality is the regulatory authority of BAAQMD. BAAQMD has approval authority over all prescribed burns in the air basin and the authority to reduce emissions by assigning Mitigation Measure AIR-1 to any prescribed burn. The oversight authority of BAAQMD to maintain air quality in conformance with the Clean Air Act would reduce the potential cumulative air quality impact to a long-term cumulative, moderate, adverse effect. By gradually lessening the potential for a large-scale wildland fire to occur with consequent high levels of air emissions, Alternative A would also have a long-term, minor, beneficial, cumulative effect on regional air quality.

Impairment

The effects of this alternative on air quality would not represent an impairment of important park resources or values.

Alternative B

Alternative B places a greater emphasis on mechanical fuel reduction, particularly in the WUI FMU. Alternative B would provide for a total of 230 acres of mechanical fuels treatment each year, primarily in Marin County. Approximately 70 acres of the 230 acres would occur as roadside fuel reduction or mowing along access roads and fire roads. Prescribed burning could occur on 120 acres of parkland each year, including the 50 acres at Muir Woods National Monument proposed for each of the alternatives. Higher permissible levels of mechanical fuel treatment under Alternative B than under Alternative A could result in a slight increase of levels of pile burning.

Mechanical Fuel Reduction

Mechanical fuel reduction would be similar to that under Alternative A and would have a short-term, negligible effect on regional air quality and visibility.

Pile Burning

Emission levels generated by pile burning under Alternative B are shown in Table 4-12. Burning of 100 piles annually could occur in Marin and San Mateo counties in either the Park Interior or the WUI FMU depending on where fuels are treated or fuel breaks are constructed. As under Alternative A, pile burning under Alternative B would have a short-term, negligible-to-minor adverse effect on regional air quality and visibility.

[1] FOFEM modeling for the PRNS FMP EIS estimated that a large-scale wildland fire, similar to the 1995 Vision Fire, could generate approximately 6,801 tons of PM_{10} and 3,395 tons of VOCs (NPS 2004a, page 234).

Table 4-12: Alternative B Annual Cumulative Emissions

Action Type	Acres	Emissions (tons per year)					
		PM_{10}	**$PM_{2.5}$**	**VOC**	**CO**	**NOx**	**SO_2**
Total All FMP Projects: Alternative B		**100.6**	**86**	**51**	**1,100.7**	**4.8**	**5.1**
Pile Burning for Community Projects Funded by Wildland-Urban Interface Initiative	25 burn piles	0.03	0.02	0.01	0.3	0	0
Total GGNRA Actions		**100.7**	**86.0**	**51.0**	**1,101.0**	**4.8**	**5.1**
Typical MCFD Annual Actions*	50-acre PB 50 burn piles	36.0	30.8	18.5	405	0.5	1.5
Total of Annual Actions by GGNRA and MCFD		**136.7**	**116.8**	**69.5**	**1,506.0**	**5.3**	**6.6**
PRNS FMP Implementation	Up to 2,000-acre PB	241.3	205	101.3	1,801.7	51.5	NG
Total Cumulative Annual Smoke Emissions		**378.0**	**321.8**	**170.8**	**3,307.7**	**56.8**	**NG**

Source: Kent Julin, Ph. D., County Forester, Marin County Fire Department 2004 and NPS Air Resources Division 2004.

Notes:

* Emissions for Marin County Fire Department (MCFD) actions are meant to be representative of averaged estimated annual accomplishments

PM_{10} = suspended particulate, $PM_{2.5}$ = fine particulate matter, VOC = volatile organic compounds (methane), CO = carbon monoxide, NOx = nitrogen oxides, SO_2 = sulfur dioxide, NG = not given, PB = prescribed burn

Prescribed Burning

FOFEM modeling for Alternative B is based on a mock annual work plan of prescribed fire project sites comprised of 27 acres of grasslands, 28 acres of coastal scrub, and 65 acres of forested understory. In addition to 50 acres in the Muir Woods FMU, the remaining acres of prescribed burning would occur in the Park Interior FMU in Marin County. This total of 120 acres of prescribed burning was modeled with the output of 100 burn piles modeled as nonnative wood debris. No prescribed burning, other than very small-scale research burns, are proposed for San Mateo or San Francisco counties. Table 4-13 shows projected annual and daily emissions for this alternative.

Prescribed burning activity under Alternative B is nearly identical in vegetation type to Alternative A. Unlike Alternative A, all prescribed burning, with the exception of pile burning, would be restricted to the Park Interior FMU away from residential areas. The principal difference for purposes of emissions modeling is an additional 15 acres of understory burning in forested areas under Alternative B. On a per-acre basis, the increase in forested areas under Alternative B produces a higher emission rate than did Alternative A. The greater level of mechanical fuel reduction under Alternative B as compared to Alternative A, with a comparable level of prescribed burning, would allow Alternative B to reduce areas of hazardous fuels in the park more quickly and contribute to decreasing the potential risk of a catastrophic wildfire, with accompanying high levels of air emissions, originating near the parklands.

Table 4-13: Projected Annual and Daily Emissions for Alternative B

ANNUAL EMISSIONS – TONS PER YEAR

Action Type	Area	Emissions (tons per year)					
		PM_{10}	$PM_{2.5}$	VOC	CO	NOx	SO_2
Prescribed Fire: Grassland and Scrub	55 acres	2.8	2.4	0.7	6.0	2.9	0.9
Prescribed Fire: Forested Understory	65 acres	93.0	79.5	48.1	1,050.4	0.8	3.7
Pile Burning	100 burn piles	0.1	0.1	0.1	1.2	0.0	0.0
Annual Emissions From Prescribed Fire		**95.9**	**82**	**48.9**	**1,057.6**	**3.7**	**4.6**
Estimated Annual Occurrence of Wildfire	39 acres	4.7	4.0	2.1	43.1	1.1	0.5
Total All FMP Projects: Alternative B		**100.6**	**86**	**51.0**	**1,100.7**	**4.8**	**5.1**

DAILY EMISSIONS –TONS PER DAY (per burn)

Action Type	Total Acres	Burns per Year	Emissions (tons per day)					
Prescribed burn totals	**120**	**6 burns total**	**PM_{10}**	**$PM_{2.5}$**	**VOC**	**CO**	**NOx**	**SO_2**
Emissions – Typical Prescribed Burn in Grassland	27	1	0.1	0.1	0.0	0.3	0.2	0.1
Emissions – Typical Prescribed Burn in Coastal Scrub	28	2	1.3	1.1	0.3	2.8	1.4	0.4
Emissions – Typical Prescribed Burn in Forested Understory	65	3	31.0	26.5	16.0	350.1	0.3	1.2

Source: NPS Air Resources Division 2004.

Notes:

PM_{10} = suspended particulate, $PM_{2.5}$ = fine particulate matter, VOC = volatile organic compounds (methane), CO = carbon monoxide, NOx = nitrogen oxides, SOx = sulfur dioxide

Alternative B would produce approximately 23 percent more fine particulates than Alternative A (82 tons per year of $PM_{2.5}$ compared to 63.7 tons per year of $PM_{2.5}$, respectively) and would have a long-term, minor adverse effect, as under Alternative A. Emissions could occur at the time of prescribed burning, would be visible locally within the park, and would be dispersed quickly during the course of the day. As under Alternative A, Alternative B would have a short-term, minor, adverse effect on visibility locally during prescribed or pile burning.

Alternative B could contribute higher levels of VOC (as methane) than Alternative A (48.9 tons per year compared to 37.8 tons per year for Alternative A). Contributions of NOx are essentially equivalent under

the two alternatives, though slightly less under Alternative B. As in Alternative A, the level of VOCs generated by Alternative B would have a long-term, moderate adverse effect on air basin air quality. NOx emissions are roughly similar under Alternative B as compared to Alternative A and would have a long-term, minor adverse effect by adding 3.7 tons per year of this ozone precursor to the air basin.

Impacts of prescribed fire activity on the surrounding communities, such as reduced visibility and smoke nuisance effects, would be reduced under Alternative B, as prescribed burning would be restricted to more remote parts of GGNRA, with the exception of proposed burning in the Muir Woods FMU and the potential for a higher level of pile burning permitted throughout all FMUs.

Research

Impacts on air quality from the use of prescribed burning for research purposes are included in the overall assessment of effect of the full 120 acres of prescribed burning permitted annually under Alternative B. There would be no effect on air quality distinct from the effect of the larger prescribed burning program.

Cumulative Impacts

The combined emissions of FMP actions under Alternative B and other GGNRA fire-related emission sources are shown in Table 4-12. As in Alternative A, other GGNRA emission sources include pile burning through Wildland-Urban Interface Initiative grants and emissions generated by wildland fire occurring in the park. With the addition of the typical annual burn program supervised by Marin County Fire Department (MCFD) staff in the county, the emission levels would increase but remain within the moderate intensity threshold. As discussed earlier, the threshold for criteria pollutants that are in attainment in the air basin is considered moderate up to 250 tons per year. The cumulative effect of all GGNRA actions plus the annual MCFD work program would create long-term, moderate, adverse cumulative impacts on $PM_{2.5}$ levels and ozone precursors NOx and VOC.

Annual tonnage of vegetation treated under the cumulative scenario in Alternative B is similar to that in Alternative A by both acreage and fuel type (110 tons in Alternative A and 120 tons in Alternative B of this EIS). As in Alternative A, the NPS concludes that the emissions of CO from prescribed burning that would be generated annually under Alternative B are included in the SIP for CO and that no further conformity analysis is warranted.

When considered in conjunction with the level of prescribed burning assessed in the PRNS FMP FEIS, air quality impacts under Alternative B would be similar to those under Alternative A. The emission levels for PM_{10}, $PM_{2.5}$, and VOC meet and exceed the threshold for a long-term, major, adverse cumulative effect on air basin emissions. The level of NOx emissions would have a long-term, minor adverse cumulative effect on air basin air quality.

As with Alternative A, the oversight of BAAQMD, the requirement to obtain BAAQMD approval for each individual burn plan, and the implementation of Mitigation Measures AIR-1 through AIR-6 to minimize the effects of prescribed burning would reduce the impact of particulates and NOx to a long-term, moderate adverse cumulative effect (see Appendix I).

By gradually lessening the potential for a large-scale wildland fire to occur, Alternative B would have a long-term, minor, beneficial, cumulative effect on regional air quality.

Conclusion

Air quality impacts of Alternative B would be greater than those estimated for Alternative A, as a larger acreage could be treated annually under Alternative B. Though more emissions would be produced annually, the level of effect based on NAAQS status would be essentially the same. The effects of particulate generation would be long-term (annually occurring), minor, and adverse, as under Alternative A. Similar to Alternative A, VOC emissions would be a long-term, moderate, and adverse, and NOx and SO2 emissions would be long-term, negligible, and adverse contributions to air basin air quality. The highest amount of emissions would be produced by one to three prescribed burns in the Muir Woods FMU, which represents approximately 75 percent of the particulate and VOC emissions produced under Alternative B. The full implementation of prescribed burning in Muir Woods is the same under each alternative and, as under Alternative A, the ability to achieve the full 50 acres annually in that FMU would depend on many constraining factors, such as availability and timing of burn days and demands on staff.

The cumulative air quality effects of Alternative B would be very similar to those of Alternative A. Full implementation of the PRNS FMP and all other actions could produce more than twice the particulates generated by GGNRA and other sources annually and would be a long-term, major adverse effect.

Impairment

The effects of this alternative on air quality would not represent an impairment of important park resources or values.

Alternative C

Alternative C provides for a total of 275 acres of mechanical fuels treatment each year. Approximately 70 acres of that treatment would occur as roadside fuel reduction or mowing along access roads and fire roads. Prescribed burning could occur on 320 acres of parkland each year, including the 50 acres in the Muir Woods FMU proposed for each of the alternatives. For purposes of air quality assessment, pile burning is estimated at 100 piles of 64 cubic feet each.

Mechanical Fuel Reduction

Alternative C would allow for a greater amount of mechanical fuel treatment than under Alternatives A and B. Equipment and vehicle use during mechanical fuel reduction projects would have a negligible, short-term, adverse effect on air quality and visibility in the opinion of the NPS Air Resources Division staff.

Pile Burning

Emission levels generated by pile burning under Alternative C are shown in Table 4-14. The same estimate for pile burning is used for Alternative B and Alternative C. As under Alternative A, pile burning under Alternative C would have a short-term, negligible-to-minor adverse effect on regional air quality and visibility.

Table 4-14: Alternative C Annual Cumulative Emissions

Action Type	Acres	Emissions (tons per year)[a]					
		PM_{10}	$PM_{2.5}$	VOC	CO	NOx	SO_2
Total All FMP Projects: Alternative C		**112.8**	**96.2**	**55.7**	**1,178.6**	**11.4**	**7.4**
Pile Burning for Community Projects Funded by Wildland-Urban Interface Initiative	25 burn piles	0.1	0.1	0.1	1.2	0	0
Total GGNRA Actions		**112.9**	**96.3**	**55.8**	**1,179.8**	**11.4**	**7.4**
Typical MCFD Annual Actions*	50-acre PB 50 burn piles	36.0	30.7	18.5	404	0.4	1.5
Total of Annual Actions by GGNRA and MCFD		**148.9**	**127.0**	**74.3**	**1,583.8**	**11.8**	**8.9**
PRNS FMP Implementation	Up to 2,000-acre PB	241.3	205	101.3	1,801.7	51.5	NG
Total Annual Smoke Emissions		**390.2**	**332.0**	**175.6**	**3,385.5**	**63.3**	**NG**

Source: Kent Julin, Ph. D., County Forester, Marin County Fire Department 2004 and NPS Air Resources Division 2004.

Notes:

* Emissions for Marin County Fire Department (MCFD) actions are meant to be representative of averaged estimated annual accomplishments.

PM_{10} = suspended particulate, $PM_{2.5}$ = fine particulate matter, VOC = volatile organic compounds (methane), CO = carbon monoxide, NOx = nitrogen oxides, SO2 = sulfur dioxide, NG = not given, PB = prescribed burns.

Prescribed Burning

Alternative C is based on a representative annual work plan totaling 320 acres of prescribed burning each year, divided among 86 acres of coastal scrub (27 percent of the total), 165 acres of grassland (52 percent), and 69 acres of understory burning in redwood/Douglas-fir forest (22 percent). Understory burning produces very high emission levels compared to prescribed burns in grass or coastal scrub. Table 4-15 shows projected annual and daily emissions for this alternative. Emission levels for fine particulates would be 92.2 tons per year under Alternative C, compared to 63.7 tons per year under Alternative A. Alternative C would therefore produce more fine particulate emissions than Alternative A. Though it could result in more frequent prescribed fires and pile burning, Alternative C would still have a short-term, minor adverse effect on visibility in the local region. VOC emissions would be higher under Alternative C, compared to Alternative A. The increase in the estimated level of NOx would be 10.3 tons per year under Alternative C, compared to 3.8 tons per year under Alternative A. This would be an increase of 63 percent over Alternative A. The increase represented by emissions produced under Alternative C would have a long-term, moderate adverse effect on levels of these ozone precursors and on air basin air quality.

Table 4-15: Projected Annual and Daily Emissions for Alternative C

ANNUAL EMISSIONS – TONS PER YEAR

Action Type	Area	Emissions (tons per year)					
		PM_{10}	$PM_{2.5}$	VOC	CO	NOx	SO_2
Prescribed Fire: Grassland and Scrub	251 acres	9.1	7.7	2.4	19.3	9.5	3.0
Prescribed Fire: Forested Understory	69 acres	98.9	84.4	51.1	1,115.0	0.8	3.9
Pile Burning	100 burn piles	0.1	0.1	0.1	1.2	0.0	0.0
Annual Emissions From Prescribed Fire		**108.1**	**92.2**	**53.6**	**1,135.5**	**10.3**	**6.9**
Estimated Annual Occurrence of Wildfire	39 acres	4.7	4.0	2.1	43.1	1.1	0.5
Total All FMP Projects: Alternative C		**112.8**	**96.2**	**55.7**	**1,178.6**	**11.4**	**7.4**

DAILY EMISSIONS – TONS PER DAY (per burn)

Action Type	Total Acres	Burns Per Year	Emissions (tons per day)					
Prescribed Burn Totals	**320 acres**	**6 burns total**	**PM_{10}**	**$PM_{2.5}$**	**VOC**	**CO**	**NOx**	**SO_2**
Emissions – Typical Grass Prescribed Burn	165	4	0.2	0.2	0.1	0.5	0.2	0.1
Emissions – Typical Scrub Prescribed Burn	86	4	2.0	1.7	0.5	4.3	2.1	0.7
Emissions – Typical Forested Understory Prescribed Burn	69	4	24.7	21.1	12.8	278.8	0.2	1.0

Source: NPS Air Resources Division 2004.

Notes:

PM_{10} = suspended particulate, $PM_{2.5}$ = fine particulate matter, VOC = volatile organic compounds (methane), CO = carbon monoxide, NOx = nitrogen oxides, SOx = sulfur dioxide

Impacts of prescribed fire activity on the surrounding communities could be more widespread under Alternative C and have greater potential for smoke to drift to nearly residential areas, as prescribed burning would be allowed in the WUI FMUs to some degree in both San Mateo and Marin counties. Only 5 acres of prescribed burning would take place in the WUI FMU in San Mateo County.

Research

Impacts on air quality from the use of prescribed burning for research purposes are included in the overall assessment of effect of the full 320 acres of prescribed burning permitted annually under Alternative C. There would be no effect on air quality distinct from the effect of the larger prescribed burning program.

Cumulative Impacts

When considering the cumulative impact scenario under Alternative C, the total annual tons of vegetation treated by prescribed burning would be 20% less than the SIP assumption for these two counties. As a contributor to the cumulative scenario, Alternative C would permit burning of roughly 2,000 tons of woody fuels annually. The majority of the tonnage to be treated annually by prescribed burning under the cumulative scenario can be attributed to the PRNS FMP which proposes a cap of 2,000 acres of prescribed burning annually in contrast to a 320-acre annual cap proposed under Alternative C of this EIS. With tonnage for the cumulative scenario calculated at 20% less than assumed for Marin and San Mateo counties under the SIP, and the probability that PRNS would not achieve 2000 acres per year of prescribed burning, the NPS concludes that prescribed burning emissions from Alternative C are included in the SIP for CO and that no further conformity analysis is warranted.

Cumulative impacts from just the GGNRA fire-related actions under Alternative C (NPS projects, Wildland-Urban Interface Initiative community projects, suppression of wildland fires) would have a long-term, cumulative, moderate, adverse effect on PM_{10} and VOC emissions generation and a long-term moderate, adverse cumulative effect on emissions of ozone precursors, NOx and VOC. This is the same outcome as was determined for Alternatives A and B.

As in Alternatives A and B, when MCFD's annual program is added to GGNRA fire-related actions, the level of cumulative effect on particulate matter is raised to a long-term, moderate and adverse effect, as more than 100 tons per year of $PM_{2.5}$ would be generated from the combined actions. Levels of NOx and VOC would also represent long-term moderate and adverse cumulative effects.

And finally, with the addition of emissions from the PRNS maximum annual program, threshold levels for particulates and NOx would exceed the threshold for a long-term major adverse effect. This impact could be minimized to a level of long-term, moderate adverse effect, as in Alternatives A and B. Mitigation Measures AIR-1 through AIR-6 could be applied and BAAQMD's authority and oversight would ensure that emission levels and the attainment status in the air basin are not compromised by excessive production of emissions through prescribed burning. Strategies to reduce air emissions are listed in Appendix I.

Alternative C follows a more accelerated regimen to reduce high fuel loading as compared to Alternatives A and B. Alternative C would result in a long-term, moderate, beneficial effect on cumulative air quality.

Conclusion

On an annual basis, Alternative C would generate the highest levels of particulate emissions among the three alternatives. This is a result of the greater number of acres treated each year by prescribed burning and the higher percentage of understory burning represented in Alternative C. Depending on the size of the prescribed burn in the forested area, levels of fine particulates generated per burn day would range from approximately 21 to 26.5 tons per burn with roughly three to four understory burns per year. On an annual basis, Alternatives A and B would result in a long-term, minor adverse effect on regional visibility. The impact is considered long-term as the effect would recur annually during the life of the FMP. The Bay Area Air Basin is in attainment for federal standards for particulate matter. Alternatives A

and B would contribute between 50 and 100 tons of additional PM_{10} annually. Alternative C would contribute approximately 110 tons per year of PM_{10}, a level of effect that is considered long-term, moderate, and adverse.

Emissions of NOx and SO_2 generated under the three alternatives would have a long-term, negligible effect.

Alternative C would annually produce the highest amount of the ozone precursor VOC at levels representing a long-term, moderate adverse effect on air basin air quality, as would Alternatives A and B. The effect is determined to be long-term due to the continued annual contribution of the FMP over the life of the planning effort (approximately 15 years). The effect is judged as moderate because the additional emissions of 53.6 tons per year are more than 5 tons per year and less than the conformity *de minimus* levels of 100 tons per year for VOC .

The annual acreage treatment under Alternative A would not appreciably reduce the potential size or severity of a catastrophic wildfire even after a decade of implementation. Under Alternative B, and more so under Alternative C, fuel reduction efforts would begin to reduce the potential for a catastrophic wildfire to occur near GGNRA lands with resultant high levels of air pollutant emissions. All alternatives would have a long-term, beneficial effect on air quality by reducing this potential for a large fire. Under Alternatives A and B, the effect would be long-term, minor and beneficial; under Alternative C, it would be long-term, moderate and beneficial.

Other FMP actions are considered to have minor or negligible effects or no effect on air quality.

Impairment

The effects of this alternative on air quality would not represent an impairment of important park resources or values.

Impacts on the Biological Environment

Impacts on Vegetation

Analysis

Numerous activities associated with wildland fire, prescribed fire, wildland fire suppression, and mechanical treatments can have either adverse or beneficial impacts on vegetation. Impacts can be sustained by individual plants or by plant communities. Examples of impacts on individual plants include direct mortality or physical damage resulting from burning, or from mowing or cutting vegetation for fire line. A plant community-level impact would occur if cutting fire line or prescribed burning led to the establishment or spread of nonnative plants, which could alter plant community species diversity and function. Mitigation such as monitoring and the removal of nonnative plants would limit these effects. This analysis is intended to reflect NPS Management Policies 2001, which states that “All cultural resource and natural resource values will be considered in defining specific treatment and management goals (NPS 2000a).

The impacts of fire on vegetation are a function of the severity of the fire itself and characteristics of the plants on the site. The ultimate response of a plant or a plant community to fire is related to the type of fire (e.g., surface vs. crown), fire behavior, fire duration, fire intensity, the season in which the fire burns, and how recently the area burned in the past. Fuel quantity and arrangement, fuel moisture content, topography (e.g., slope and aspect), wind speed, and the structure of the plant community itself cause the lethal heat zone to vary significantly in time and space (Miller 2000). This means fire effects on plants can vary not only widely among fires, but also among different areas of the same fire.

Species and individual plants respond uniquely to fire based on plant age, vigor, morphology, reproductive strategies (e.g., seeders vs. sprouters), germination requirements, and phenological state at the time of the fire. Trees, shrubs, and herbaceous species all respond differently to fire and exhibit numerous strategies for post-fire colonization, including sprouting and seeding. The amount of subsurface heating that occurs, as well as the amount of organic matter removed from the soil surface, affects plants and regeneration. Post-fire weather also influences post-fire species establishment (e.g., which species will recolonize the site and how quickly) and affects the success of newly established plants.

Post-fire plant communities, at least for the first few years following the fire, are comprised of species that have the following regeneration strategies: plants that survived the fire, plants that produced sprouts or suckers from the base or from protected aerial reproductive structures, or plants that established from seed. Seedlings that establish on a burned site are derived from seeds that were dispersed from plants that survived the fire (usually trees), were dispersed onto the site from adjacent unburned areas, were in the soil seed bank that were stimulated to germinate by the fire, or came from plants within the fire that resprouted following the fire (Miller 2000).

Types of Effects from Prescribed Burning

Prescribed fire can result in direct mortality, can damage plants or seeds, and can change plant community structure and species composition. The primary difference, however, between unplanned wildland fire and prescribed fire is that prescribed fires are conducted under a rigid set of prescriptive parameters, including air temperature, fuel moisture, and wind speed. Prescribed fire planners and managers, therefore, exercise careful control over when and where the burns occur, and site-specific prescriptions are developed to meet set objectives relative to vegetation.

The impacts associated with line construction, holding, monitoring, and mop-up of prescribed fires would be similar to those described in the following section addressing suppression of unplanned wildland fire. These impacts, however, would be less substantial with prescribed fire because fire would be carefully planned to minimize impacts and would be implemented under controlled conditions.

Types of Effects from Wildland Fires and Suppression

The direct effects of unplanned wildland fires on vegetation can be substantial, including long-term, possibly permanent changes in plant species composition or percent cover, and the introduction or spread of nonnative plant species. However, in burned areas where a high percentage of trees survive and native understory vegetation resprouts, it can be difficult to determine that a fire has recently occurred.

Actions Common to All Alternatives

Wildland-Urban Interface Initiative

The emphasis of the Wildland-Urban Interface Initiative at GGNRA is to reduce the density of hazardous fuels that create a risk to lives or property on parklands adjacent to the park boundary. Most projects would continue to focus upon the mechanical removal of nonnative and highly flammable eucalyptus and acacia trees and nonnative shrubs (cotoneaster, brooms) from areas where parklands are adjacent to neighboring properties. The removal of these nonnative species would have two primary long-term benefits: reducing the chances for large, high-intensity burns, and promoting or allowing for the reestablishment of more compatible native vegetation close to developments. For example, native species of oak and California bay laurel, which typically inhabit sites where eucalypts have invaded, provide key habitat for wildlife species and patchy year-round shade for the development of diverse and less flammable native plant assemblages, including coastal scrubland and hardwood forests. Mechanical removal activities would remove vegetation, disturb soil and forest litter, and change shade and moisture characteristics through loss of overstory cover. With mitigations, including development and implementation of revegetation and weed efforts in conjunction with Wildland-Urban Interface Initiative projects, these short-term adverse impacts would result in minor long-term beneficial impacts on vegetation.

Defensible Space/Vegetation Clearing Around Structures

The creation of defensible spaces around structures would remove vegetation and disturb soil and litter, with the possibility of increasing cover of nonnative plant species following soil disturbance. However, these species could easily be removed due to their proximity to frequently used areas of the park, and new invasions would be detected early enough to avoid spread into adjacent wildlands. Impacts would be minor to negligible, adverse, and long-term because treatments would need to be repeated.

Roadside Fuel Reduction

Fire road maintenance would remove vegetation adjacent to road edges, creating open and available habitat for the invasion of nonnative plant species. Efforts already underway in the park to mitigate these effects (e.g., minimizing soil and ground litter disturbance by increasing the height of mower blades) have seen some reduction in this predictable incursion of nonnative plant species. A number of studies have shown that roads serve as vectors for intrusion of new nonnative plants, which can “hitch a ride” on passing vehicles, pedestrians, and other fire road users. Therefore, identification of needed fire roads is critical, and downgrading of unnecessary fire roads to trails or complete road obliteration should be a priority for fire management personnel. Annual roadside surveys, an action common to all alternatives, can help detect and stop the spread of new nonnative species. Maintaining fire roads would have greater impacts on vegetation than clearing defensible space around buildings because some portions of fire roads run through interior, relatively intact vegetation communities in the park. Impacts would be minor to moderate, depending on the integrity of the surrounding vegetation; adverse; and long-term because treatments would be repeated.

Suppression

Activities associated with suppression of wildland fire can kill or damage native vegetation. Adverse effects on vegetation can result from fire suppression activities such as construction and use of staging areas, helispots, or spike camps; construction of fire lines using hand tools or bulldozers; cutting of snags; and mop-up. Maintaining control of prescribed fires can also involve hand line construction, snag removal, water drops, and other actions, but such efforts are likely to be much less intense and have less impact than they would during wildland fire suppression. The impacts of hand line construction in association with managed wildland fire, in conjunction with mitigation measures, would be adverse, short-term, and negligible given the present limited amount of wildland fire that occurs and the relatively limited use of prescribed fire called for in the GGNRA FMP alternatives.

Individual plants and plant communities can be damaged or destroyed when vehicles are traveling to sites or staging areas or when bulldozers are constructing fire lines, creating avenues for nonnative plant establishment through soil disturbance, loss of native vegetation cover, and changes in light and moisture conditions. It is anticipated that in most cases these impacts would occur infrequently. Similar effects could result from removal or trampling of vegetation in temporary staging areas and helispots used for suppression activities. Spills of fuel, oil, hydraulic fluid, antifreeze, and other toxic chemicals at staging areas and helispots could adversely affect vegetation though changes in soil chemistry, hydrophobicity, and water uptake properties, especially if spills occur in wetter environments such as riparian forest and scrub and herbaceous wetland communities. All landing areas will meet the standards outlined in the Interagency Helicopter Operations Guide, and safe landing spots identified in the GGNRA Aviation Management Plan mitigations would be used. These mitigations, in addition to limiting helispot construction and locating helispots away from sensitive resources, would reduce these impacts.

Use of water or retardant drops during suppression activities can have both a direct adverse impact – from the sheer force of the physical impact – and a longer-term chemical impact due to the chemical composition of the materials used. Most fire retardants contain fertilizer-type compounds, including ammonia, nitrogen, and phosphorous, that can change vegetation, especially in areas low in nitrate/ammonia-type nutrients. Added nutrients can decrease growth of native vegetation and increase the establishment of nonnative species that favor higher nutrient levels, or can stimulate unnatural growth spurts during drought-stressed periods of the year (when fires are most common), causing longer-term stress to individual plants. Impacts can be mitigated by avoiding use of retardant or by using “clear” retardant that has minimal active nutrients within the mix. Retardants can cause short-term impacts on the overall health and reproductive ability of some species, although fall and winter rains leach these chemicals out of the system and long-term effects are not detectable.

The proximity of saltwater to most areas of GGNRA means there is a high likelihood for the use of saltwater or brackish bay water during suppression actions. Short-term die-back in annual species can result if salts are concentrated in drainages and swales. Again, these impacts are generally short-term as the annual rains flush salts out of the system. In addition, most vegetation communities in the park are adapted to some salt deposition from fog cover, so overall impacts are negligible from the chemical standpoint, and minor to negligible from the direct impact (force of water/retardant falls) on plants. The advantage of water and retardant drops is that in some circumstances they can take the place of hand lines

("wet-lining") to control fire movement. This tactic results in less physical impact on soils, forest litter, and vegetation than hand line construction.

Personnel at fire camps or on suppression crews have the potential to transport weed seeds with their equipment and tools, which may have long-term adverse impacts on vegetation composition. They also cause trampling and loss of vegetation cover, which could have short- to long-term, negligible, adverse impacts. However, locating spike camps away from sensitive resources such as shrub lands and riparian/wetlands areas would help minimize these impacts.

Hand line construction would remove vegetation and disturb soil and forest litter, leading to soil erosion and loss of native seedbanks and soil structure. In all cases, minimum impact suppression tactics (MIST) would be used to minimize ground disturbance, including use of wet lines and construction of minimal hand lines through the use of mowers to break up fuel continuity and retain vegetation stems on the ground surface (see Appendix G).

Mop-up, or the churning of soil and forest litter to extinguish residual hot spots along the periphery of a fire, would cause additional impacts on soil integrity and the soil seedbank, creating an increased potential for introduction and establishment of nonnative plant species within native plant stands. These actions could also stimulate sprouting of hard-coated seeds including French broom, Scotch broom, cotoneaster, and other species typically found in grasslands, coastal scrub, and the understory of nonnative evergreen forests. Although "flushes" of weedy species would occur after ground-disturbing activities, these actions would also speed up the removal of weed seed in the seedbank, which, in conjunction with ongoing vegetation management of post-fire areas (to prevent sprouted seeds from reaching maturity and gong to seed again), would gradually eliminate these species from the burn area.

The use of a flexible suppression strategy wherever possible can help mitigate potential adverse impacts, as discussed above. Use of indirect fire lines to take advantage of either natural firebreaks (rock outcrops, bodies of water) or roads or otherwise devegetated areas would have a substantial beneficial effect on natural vegetation areas by minimizing ground disturbance through the construction of direct fire lines with hand tools and machinery. This flexible strategy would allow fire personnel to direct wildland fires toward areas of lower fuel loads, such as previously thinned or cleared WUI sites, such that suppression fire lines could be smaller and less intrusive on the landscape. (This is because line width and extent change based on the fuel that the line is being cut through; lines through grass are minimal, whereas control lines through forested areas can be substantial, with large areas of ground disturbance and vegetation loss.) Using this strategy would reduce the level of effect to a negligible-to-minor adverse impact on vegetation, with long-term effects.

Treatment of Muir Woods FMU

Fire actions for Muir Woods FMU would include a mix of prescribed fire, mechanical fuel reduction, and understory thinning projects. Prescribed burning would be conducted to reduce fuel loading and restore vegetation structure and composition to areas with high nonnative plant components, as well as to restore the disturbance role fire plays within the coastal scrub and chaparral, grassland, and redwood/Douglas-fir ecosystem. Burns would range in size from 0.5 to 50 acres annually in a variety of vegetation

communities. Research burns would be conducted to investigate how fire affects the spread and control of the Sudden Oak Death (SOD) pathogen, *Phytophthora ramorum*.

Adverse impacts on vegetation from fire management actions would largely be associated with undesired changes in vegetation composition and structure. This could include introductions or increases in existing nonnative plant species and cover, alterations of vegetation communities to conditions that will not sustain the native species components (such as removal of overstory trees in riparian corridors), and substantially increased fuel loads that could support higher-intensity wildland or prescribed fires. Careful consideration of fire management activities, including adherence to sound prescribed burn prescriptions, review of burn objectives with natural resources staff, and adequate planning and implementation of pre- and post-burn weed treatments, would mitigate these impacts. Fire actions in forest and woodland areas typically produce an initial increase in fuel loads (due to understory mortality), but should not adversely affect long-term vegetation characteristics. The adverse impacts of fire management actions in most cases would be minor and short-term due to the limited areas that would be affected, and negligible with inclusion of all mitigation measures. Long-term beneficial impacts would result from fire actions that restore and enhance native plant communities and vegetation structure.

Fire management activities in nonforested areas (grassland, coastal scrub, and chaparral) would have similar long-term beneficial effects by restoring native plant communities and vegetation structure. Adherence to specific mitigation measures, such as minimizing ground disturbance activities during implementation of fire actions, using carefully designed prescriptions and adhering to those prescriptions, and developing and evaluating specific project objectives, would result in minor-to-major beneficial effects, depending on the condition of the site prior to the action. For example, a prescribed burn implemented in an area with a dominant nonnative grass cover, such as Harding grass, that was converted to native grassland through careful burn implementation would have a major beneficial effect on the park's grassland community. Sites with little to no nonnative component that were maintained at those same levels through fire actions, such as burning in hardwood forest understory areas, would have a minor beneficial effect. Actions that enhance the opportunity for coast redwoods within Muir Woods National Monument to out-compete encroaching Douglas-fir saplings, either through removal of encroaching trees or improved redwood regeneration, would have a moderate beneficial impact with long-term effects.

Fire management actions would have many long-term benefits in Muir Woods National Monument. Reducing the chances for catastrophic fire would prevent the loss of the last contiguous stand of old-growth coast redwood forest in the region, as well as protect portions of the Redwood Creek watershed. Research on fire effects on SOD may lead to ways to control the pathogen and prevent excessive loss of the tan oak understory, which provides cover and acorns for wildlife. Removal of nonnative plants and restoration of natural stand structures and ground litter load would foster the reestablishment of native plant species.

Treatment of San Francisco County Project Area

The fuel reduction strategy for San Francisco lands focuses upon maintaining defensible spaces around buildings (see discussion above) and removing nonnative trees, with small research burns in association

with listed threatened and endangered plant species. These actions would remove vegetation and could disturb soil and litter, possibly increasing the potential for establishment of nonnative plant species. Adverse effects would be long-term and minor.

Public Information and Fire Education Programs

Impacts associated with public information and education would largely be indirect and beneficial, although highly dependent on the nature of the fire management action. Pre-planned events such as prescribed fires and mechanical treatment provide the opportunity to demonstrate the effectiveness of natural resource management to local communities and the interested public. During unplanned events, such as wildfires, time for effective communication is often more limited and education efforts can be more controversial since resources are often damaged. However, public information and education could have an indirect positive effect on vegetation. For example, education can be used to enforce a closure of an area to ensure quick habitat recovery or to increase recruitment of stewardship volunteers for revegetation or weeding projects associated with fire management activities.

Fire Cache

Centrally locating the fire cache and management personnel within GGNRA allows for faster response time to wildfires, implying less potential for higher-intensity and larger fires, as well as less intensive suppression activities. The use of existing buildings for the fire cache would avoid impacts on vegetation from construction activities. Fire cache relocation would have indirect, beneficial, long-term effects on vegetation.

Fire Effects Monitoring

There would be some trampling and disturbance effects associated with onsite monitoring of vegetation and fuels, although these would be relatively minor. The timing of monitoring would influence the intensity of these effects. For example, conducting field work during early spring growth when herbaceous species are easily crushed and soils are wet and erodible would have a very localized minor adverse effect. The knowledge gained, however, through monitoring and subsequent data analysis would be beneficial to vegetation. By gaining a better understanding of how fire behaves in different vegetation communities and in different weather and climatic conditions, park fire specialists would be better able to avoid catastrophic fire events and use fire management actions to enhance vegetation structure and composition. Overall, the impacts associates with monitoring fire effects would be minor to moderate, long-term, and beneficial.

Alternative A

Mechanical Fuel Reduction

Approximately 100 acres of vegetation would be mechanically treated under this alternative, reflecting the current level of park practices. Work would continue to be focused on the removal of nonnative, highly flammable vegetation in Marin, San Francisco, and San Mateo counties; the second-growth redwood/Douglas-fir at Muir Woods National Monument; and the grassland and coastal scrub in all three counties, with an emphasis on Marin County. The focus of treatment would be removal of eucalyptus, Monterey pine and cypress, acacia, and other flammable trees along the urban interface, with some

removal of Scotch and French broom to reduce fire hazards and limit the potential spread of these nonnative species through reduction of mature plants. Some mechanical fuel reduction work would take place under this alternative in the second-growth redwood/Douglas-fir FMU to reduce fire hazards and facilitate implementation of prescribed burns. Some soil disturbance would occur during this work due to the use of chipping and hauling equipment, with associated potential for nonnative plant species establishment or spread. Follow-up nonnative plant monitoring and removal would be conducted to remove new recruits that come into the site in years following mechanical treatments.

Coastal Scrub and Chaparral. Under Alternative A, mechanical treatments would be used to remove individual trees and tree patches, and stands of broom. Access to these sites would be along maintained fire roads. Most actions would be done in conjunction with follow-up pile or prescribed burn treatments. Short-term adverse negligible-to-minor impacts could result from these actions due to immediate trampling and soil disturbance impacts. Long-term effects of mechanical treatments on this community would be beneficial because the continuity and ecological integrity of scrub and chaparral would be improved through management of nonnative shrubs and Douglas-fir trees that have encroached into both communities, but the overall effect would be negligible to minor due to the very limited nature of this type of action under Alternative A.

Grasslands. Where Scotch and French broom occur in grasslands, mechanical treatment with hand tools would be used to help control the spread of these species and reduce fire hazards. Overall impacts would be similar to those for the coastal scrub and chaparral vegetation community; short-term adverse negligible-to-minor impacts could result from these actions due to immediate trampling and soil disturbance impacts. Long-term effects of mechanical treatments on this community would be beneficial, but negligible to minor due to the very limited nature of this type of action under Alternative A.

Herbaceous Wetlands. No mechanical treatment would occur within herbaceous wetlands under this alternative, aside from nonnative nonhistoric tree and shrub removal to restore wetland integrity. With mitigations listed in Chapter 2, the effects of these actions would be long-term, minor, and beneficial

Riparian Forest and Scrub. No mechanical treatment would occur within riparian woodland under this alternative, aside from nonnative nonhistoric tree and shrub removal to restore riparian forest and scrub integrity. With mitigations listed in Chapter 2, the effects of these actions would be long-term, minor, and beneficial.

Native Hardwood Forest. No mechanical treatment would occur within native hardwood forests under this alternative, aside from nonnative nonhistoric tree and shrub removal. With mitigations listed in Chapter 2, the effects of these actions would be long-term, minor, and beneficial.

Douglas-Fir and Coast Redwood. Mechanical treatments in this community would focus on removal of understory fuel accumulations, including dead and down trees and shrubs and nonnative shrubs (cotoneaster, brooms). These actions would help reduce the possibility of high-intensity fires facilitated by ample ladder fuels, and would also prepare areas for future prescribed burns. Most mechanical fuel efforts would have follow-up pile burns. Since these actions would potentially occur over larger areas within this community (as opposed to isolated stands in grassland and coastal scrub/chaparral), short-term

impacts would be more obvious, with increased impacts on soils and understory herbaceous vegetation having minor adverse effects. There would be a decrease in nonnative species abundance, with an increased potential for the establishment of native understory plant species more characteristic of these stands, a decreased potential for unnaturally high-intensity burns, and an increased likelihood of restoration of these stands to a more sustainable condition. Long-term impacts would be beneficial and minor.

Nonnative Evergreen Forest. Mechanical treatments under Alternative A would be focused on this plant community throughout the park. Short-term impacts would be adverse due to ground and soil disturbance, but long-term impacts would be beneficial and minor to moderate, depending on the extent of work on an annual basis. Current park operations in this community are focusing on lands in Marin County, and this area would receive the greatest benefit from mechanical treatments for the reasons mentioned above. Follow-up removal of nonnative species would be a necessary mitigation to ensure that these initial efforts are successful in reducing fire hazards, changing overall vegetation structure to less flammable conditions, and restoring sites to appropriate vegetation communities (including coastal scrub, native hardwood forests, and grasslands). Any existing cultural, as well as natural, resource values would be considered in defining specific treatment and management goals for this vegetation type.

Pile Burning

Piles of cut vegetation could be burned following mechanical treatments as a means to reduce fuel loading in an area. These piles would be constructed away from sensitive resources, such as wet areas and sensitive species habitat, to prevent impacts from heat intensity that occur when piles are burned. Piles would be limited in size, and would be burned during seasons when the potential for fire spread and impacts on adjacent native vegetation would be minimal, such as during the fall after the first rains. This timing means live fuel moistures would be increased and rain-induced seed germination or resprouting of senescent perennial plant species would not yet have begun, so impacts would be minimal. Timing as a mitigation to reduce impacts from pile burning can thus ameliorate the direct-burning impacts on soils and vegetation. Pile burns under this alternative would focus only on those plant communities mentioned above in association with mechanical treatments: coastal scrub and chaparral, grasslands, Douglas-fir and coast redwood, and nonnative evergreen forests. Pile burning, with associate applicable mitigations, would result in short-term direct impacts on the underlying soils, with negligible effects. Long-term impacts would be minor and beneficial in that overall vegetation structure and composition would be improved through the removal of nonnative species and the restoration of native species habitat.

Prescribed Burning

The FMUs or plant communities that could be treated with prescribed fire under this alternative are the grassland and coastal scrub, broadleaf evergreen forest, old-growth redwood forest, and second-growth redwood and Douglas-fir. The chaparral FMU would not be treated with prescribed fire under this alternative. As noted in Chapter 2, Alternatives, of this EIS, the primary focus of treatment would be to manage hazardous fuels in strategic locations such as along the wildland urban interface, to mimic the effects of natural fires, and to aid in controlling nonnative plant species including Scotch broom, French broom, eucalyptus, and cotoneaster.

Coastal Scrub and Chaparral. Prescribed fire would be used to continue efforts to reduce the extent and density of nonnative plant species including Scotch broom and French broom, which are common inhabitants of the GNNRA coastal scrub community. Burning would also be used as a follow-up to mechanical treatments for these species and nonnative trees such as eucalyptus and pine within the coastal scrub community.

Control of broom species through fire has been achieved by meeting specific temperatures to kill broom seeds. Heat greater than 150 degrees Celsius (C) for more than two minutes kills the majority of the Scotch broom seeds, and heat greater than 100 degrees C for one minute increases susceptibility of this species to fungal pathogens. Cooler burns have resulted in significantly increased Scotch broom seed germination. French broom seeds are killed when soil temperatures reach 125 degrees C for one minute. Effective control of both species, as proven by multiyear efforts at Point Reyes National Seashore and at Redwood national and state parks in northern California, involves a combination of cutting at the end of the dry season to decrease the rate of resprouting (the plants are stressed due to summer drought conditions), and a later fall burn repeated every other year for several years. This combination of actions removes reproducing broom plants and either kills the seeds or induces seed germination. Follow-up burns (or mechanical removal) kill the newly sprouted plants, preventing new additions of seed into the seedbank. Over time, seeds are either killed or flushed from the soil and adult plants are removed, leading to a gradual shift in species cover to native perennial grasses and forbs.

Repeated burning to manage broom also prevents coastal scrub species such as *Artemisia* and ceanothus from surviving, since the mechanism for removal of broom works equally well on native shrubs. Current practices with prescribed burning in the coastal scrub community are extremely limited, and generally occur in areas that have recently transitioned from grassland to coastal scrub. Therefore, these treatments would have a long-term, minor-to-negligible, adverse impact on coastal scrub, since the scrub extent would be reduced, but the nonnative species component within the grassland-scrub transition would be eliminated over time.

Low-intensity prescribed burns in scrub or chaparral may include isolated, single, nonnative trees or small stands of nonnatives. If the trees are historically significant, they may be limbed up to prevent the spread of fire into the canopy and maintained in the burn unit where a low-intensity fire is anticipated. If nonnative trees are not historically significant, they would be cut before the burn and, if necessary, the stump would be treated with herbicide. Repeat applications of fire would not be needed with subsequent survival of the coastal scrub component. These actions would have long-term minor beneficial effects on the coastal scrub community due to the increase in available habitat for coastal scrub vegetation.

Lack of burning within the chaparral community could have short-term adverse impacts on the fire-adapted plant species within the chaparral, some of which are locally rare. Fire stimulates regeneration, and impedes the continued encroachment of Douglas-fir trees into the chaparral. The continually increasing fuel load in the chaparral along Bolinas Ridge and near Muir Woods National Monument would eventually support a planned or unplanned ignition, and the vegetation within these stands would recover in accordance with their species-specific adaptations. Therefore, the chaparral communities would incur negligible, adverse effects under Alternative A.

Grasslands. Prescribed burns could occur in both Marin and San Mateo county grasslands under Alternative A. In keeping with NPS and GGNRA objectives to reduce the overall extent of nonnative plant species and encourage native plant species under prescribed fire would be used in combination with mechanical treatments and/or herbicides. Dominant nonnative plant species in grasslands include velvet grass, annual wild rye, perennial ryegrass, small fescue, foxtail fescue, erharta grass, and Harding grass. Dominant native grass species include California purple needlegrass, tufted hairgrass, California brome, Pacific reedgrass, California oatgrass, and meadow barley. Many of the native species are either undamaged by prescribed fire or appear to be stimulated by it, either because seeds are buried and remain unaffected by all but very hot fires, or the plant sprouts from buried structures, such as rhizomes or root crown, in the growing season following the burn. The nonnative species may or may not be negatively affected by burning. Harding grass, for example, appears to be stimulated by fall burns, but is effectively killed by early spring burning. A recent analysis of monitoring data from the PRNS prescribed burning program did not identify any one strategy that consistently favored native species relative to nonnative species (Twedt 2003). Rather, the outcomes were very case- and site-specific. For example, while a combination of prescribed fire and mowing has been successful in removing Scotch broom from some grassland communities, prescribed burning of the highly invasive purple velvet grass may be increasing its abundance.

Efforts to study the effects of prescribed burns on specific species and grassland communities would continue under this alternative. The effects of prescribed burning on grasslands would be carefully monitored to assess post-burn plant species cover and composition. If monitoring shows undesirable effects, such as an increase in nonnative plant cover or distribution, either the prescription would be changed (e.g., burn during different seasons) or combined with other treatments (such as seeding of native plant species), or other strategies would be tried. All applicable mitigation measures would be applied to these burns, including continued monitoring, adherence to site-specific prescriptions, development and analysis of specific burn objectives, and alteration of prescriptions based on those monitoring results. Prescribed burns in the grassland and coastal scrub communities would result in a long-term negligible-to-minor beneficial impact on the grassland community because of the expected increased extent of grassland species and control of specific nonnative species. Continued studies and adjustment of burn prescriptions could result in moderate beneficial impacts on this community over time.

Herbaceous Wetlands. Herbaceous wetland vegetation grows alongside rivers, streams, and creeks. In GGNRA, herbaceous wetlands would not be treated with prescribed fire, and a suitable buffer would be maintained if fire management activities were to occur in the vicinity of wetlands supporting special status species. The buffer would be created through use of a wet line or other means to avoid use of a scraped hand line, so that impacts on herbaceous wetland species would be avoided.

Riparian Forest and Scrub. Riparian vegetation grows alongside rivers, streams, and creeks. In GGNRA, riparian woodlands and shrublands would not be treated with prescribed fire, and a suitable buffer would be maintained if fire management activities were to occur in the vicinity of riparian areas supporting special status species. The buffer would be created through use of a wet line or other means that avoid use of a scraped hand line, so that direct impacts on riparian species would be avoided.

Native Hardwood Forest. Hardwood forests occur in the broadleaf evergreen forest FMU under Alternative A. Limited prescribed burning could be conducted in small areas supporting hardwood forests, but only where such forest borders grasslands or stands of Scotch or French broom, or where specific research plots are located. Under current park practices (as represented by Alternative A) specific burns within the hardwood forest community are not projected to occur except where these actions would reduce fuel loads or help control nonnative plant species. Mitigations applicable to this vegetation type would include follow-up nonnative plant monitoring and removal, and development of stabilization plans to prevent new recruits following prescribed burning. Therefore, prescribed fire effects on species dominant in hardwood forests would have negligible beneficial long-term impacts on these forests, resulting in improved forest health.

Douglas-Fir and Coast Redwood. This vegetation type occurs in both Marin and San Mateo counties, within the old-growth redwood and second-growth redwood and Douglas-fir FMUs. Numerous prescribed burns have taken place within this vegetation type in Marin County, but none has occurred under the 1993 FMP in San Mateo County. As described in Chapter 3, Affected Environment, of this document, fire can have both beneficial and adverse impacts on this vegetation type depending on season, mitigation measures applied, and follow-up treatments to control invading nonnative plant species. The primary objectives of past burn efforts have been to reduce fuel loads where hazardous accumulations have occurred, and to reintroduce fire as a disturbance process into the redwood forest ecosystem. These general objectives have been successfully met, and actions under Alternative A would continue to improve the overall condition of these forests. The encroachment of Douglas-fir trees into coast redwood-dominated stands would be impeded through prescribed burns, and the overall extent of the coast redwood stands would either remain stable or slightly increase as competition from Douglas-fir trees is reduced.

The only stands of this vegetation type on GGNRA lands in San Mateo County are at the Phleger Estate. These second-growth forests are a mix of both Douglas-fir and coast redwood, with a sub-overstory of old hardwood trees that became established following logging of the site in the late 1800s. This area has never been treated with prescribed burning under the current FMP. Research burns within second-growth stands would contribute to the body of knowledge regarding the effectiveness of using prescribed fire to restore old-growth stand characteristics to second-growth coast redwood forests. Some work has been done in this regard at Big Sur State Park south of Monterey, and park staff would work closely with state park personnel if research actions were proposed for this area.

Prescribed burning would have positive effects on coast redwood forest with the inclusion of applicable mitigations, including adherence to specific prescriptions, development of specific burn objectives and post-fire analysis to determine achievement of objectives, and minimization of ground-disturbing activities during burn site preparation, implementation, and clean-up. Prescribed burning within this vegetation type under Alternative A would have long-term negligible-to-minor beneficial effects due to the limited acreage allotted to burning in San Mateo County and the limited annual burn window.

Research

Research projects would examine the role of fire in enhancing natural resources and the effects of fire on specific natural resources to determine the effectiveness of various treatment strategies. For example, research would continue on Harding grass and Scotch and French broom to help ecologists refine burning prescription parameters to control these species. This could have substantial benefits to the coastal scrub and grassland communities both within the park and regionally where these vegetation-based species continue to expand. Alternative A would allow for additional research or test plots in each of the six FMUs, and specific research questions would be formulated for these other areas. Research into the effects of fire on SOD would potentially help manage this pathogen and reduce its impacts on the native hardwood Douglas-fir and coast redwood forests of the park. The overall impact of research on vegetation communities under Alternative A would be a long-term, negligible benefit.

Cumulative Impacts

Primary among the past actions that have influenced vegetation at GGNRA are fire suppression (especially in areas that were sustained by fire), urban development and loss of habitat continuity, and the establishment and overall dominance of many areas by nonnative plant species.

Suppression of periodic fires has favored fire-intolerant species and nonnative species, and allowed the unnatural buildup of both dead and live fuels. Shrub and grassland habitats are experiencing encroachment by fire-intolerant conifers and nonnative trees. The buildup of fuels, or change in fuel density from grasses- and forbs-dominated communities to tree- and shrub-dominated communities, generally increase the risk of a high-intensity wildfire.

Urban development has also contributed to changes in composition and density of key species. For example, redwood forest is estimated to have covered 1,976, 000 acres 200 years ago. Today, approximately 85,000 acres are left. Four percent of the original old-growth forest remains. In 1986, aerial photo interpretation estimated 1.26 million acres of second growth redwood forest covering 63 percent of the former range. At that time, old-growth redwood was confined to 208,000 acres, of which 54 percent was in public ownership. Nearly 60 percent (53,000 acres) of the old-growth forest in private ownership was harvested in the next 10 years (1986-1996). So in the decade of 1986-1996, 25 percent of the remaining old-growth coast redwood forest was cut. Muir Woods National Monument contains 300 acres of old growth forest (Fox 1996). Analysis of pollen from coast live oak (the dominant tree of the park’s hardwood forests) shows that oak woodlands were stable for up to four centuries before major European-American settlement. Fire suppression efforts beginning in 1870 and extending into recent years resulted in a two-fold increase in oak pollen and oak density, perhaps facilitating the spread and effect of the nonnative Sudden Oak Death pathogen. Monterey pine, Monterey cypress, and eucalyptus have all been imported by European-American settlers for lumber or other purposes. Eucalyptus in particular has been a prolific “weed tree” over much of California. Coastal sage scrub is present in about 15 percent of its former habitat, primarily because of agricultural, industrial, and residential development. Grasslands in California have been invaded by nonnative species in part because of the displacement of native tule elk by domestic livestock, the introduction of nonnative plant species adapted to livestock grazing, and the clearing and plowing of land for agriculture. Scotch and French broom are escaped ornamental shrubs brought from Europe, and most of the park’s nonnative grasses are imported from

Eurasia. All are highly invasive species that occur in grasslands and coastal scrub in the park, and all are adapted to the area's Mediterranean climate.

Current and reasonably foreseeable future actions positively affecting vegetation in the park are activities such as the Big Lagoon, Redwood Creek, and mission blue butterfly habitat restoration projects. These projects take into account the natural processes of the site and incorporate nonnative plant removal and establishment of native plant communities (through planting and weed removal) into their efforts. Potentially adverse impacts could occur with development projects both within the park and adjacent to park boundaries, including the various transportation plans and trails plans. These efforts will involve ground disturbance activities that could add to or exacerbate existing nonnative plant problems along road and trial corridors. However, ongoing efforts to identify mitigations for these projects, such as pre-project weed control, post-project planting and weeding, and use of weed-free products (soils, fill material, and clean equipment), would reduce the potential for these type of impacts. These projects would have an overall long-term negligible-to-minor beneficial impact on vegetation as a whole.

Conclusion

Limited prescribed burning and mechanical fuel treatments would have negligible-to-minor beneficial long-term impacts on coastal scrub and chaparral communities due to continued work to control nonnative species with increased available habitat for native scrub species. Prescribed burning and research within the native hardwood forests would create a minor beneficial impact in these stands, resulting in improved forest health. Removal of individual nonnative trees would have a localized minor-to-moderate long-term beneficial impact on native vegetation, but these beneficial impacts would only persist if follow-up activities to remove new recruits were carried out after prescribed burning or mechanical treatments. Adverse, minor, short-term impacts could occur as a result of application of fire management activities if other nonnative plant species invade or spread into treated sites. Prescribed burns in grasslands could have negligible-to-beneficial impacts, and more study is necessary to determine the overall effects if this treatment is to be used on a large-scale basis in the park.

The average annual occurrences of wildfires and their suppression could have minor, short-term adverse or beneficial impacts on vegetation. Benefits may result from stimulation of fire-adapted native species, or from the destruction of nonnative plants. Adverse impacts may come from the loss of native species with subsequent establishment of nonnative plant species in newly available habitat, as well as from crushing, removal, or other physical impacts of suppression actions.

Mechanical fuel reduction in Douglas-fir and hardwood forests would result in negligible-to-minor short-term adverse impacts. Minor-to-moderate benefits to coastal scrub and grasslands from the continued removal of Scotch broom and French broom would result from the combination of mechanical and prescribed burning techniques. The continuation of research and wide application of its results would increase these benefits over a wider geographic area. Riparian and wetland areas would be minimally affected under this alternative due to the use of buffers and appropriate mitigation measures.

Overall, the cumulative effects of past, present, and reasonably foreseeable future actions in conjunction with actions called for in this alternative would have long-term negligible-to-minor and adverse effects on vegetation, due to the extent of nonnative plant species dominance in many areas of the park, the lack of

current fire management actions in many areas of the park, and lack of actions focused on nonurban interface areas.

Impairment

Overall, Alternative A would have a short term, minor, adverse effect on vegetation. As the level of intensity of impacts would not exceed moderate, no impairment of vegetation resources would result.

Alternative B

Mechanical Fuel Reduction

Under this alternative, up to 230 acres of vegetation would be mechanically treated on an annual basis. Work would focus on the WUI FMU in Marin, San Francisco, and San Mateo counties, the Muir Woods FMU in Marin County, and the Park Interior FMU. Hazardous fuel reduction treatments would include removal of eucalyptus, Monterey pine and cypress, acacia, and other flammable trees along the urban interface. Scotch and French broom and other nonnative plant species would be removed where they pose a fire hazard. Some soil disturbance would occur during this work due to the use of chipping and hauling equipment, with associated potential for nonnative plant species establishment or spread. Follow-up nonnative plant monitoring and removal would be conducted to remove new recruits that come into the site in years following mechanical treatments.

Coastal Scrub and Chaparral. Treatment of coastal scrub and chaparral areas under Alternative B would focus primarily on those areas where fuel buildups pose a threat to developments, such as adjacent to developments at Sweeney Ridge, Tam Valley, and Stinson Beach. These treatments would generally be within the WUI FMU, although some lower priority sites within the Park Interior FMU could be treated. The overall number of acres to be treated would be more than double the area treated in Alternative A, but the distribution of those treatment actions would be more confined along the wildland urban interface. Access would continue to be via maintained fire roads. Most actions would be done in conjunction with follow-up pile burns. Due to the expanded number of acres that could be treated under this alternative, short-term adverse impacts would increase to minor due to more concentrated trampling and soil disturbance impacts. There would be minimal to no increases in overall habitat continuity and ecological integrity of scrub and chaparral stands due to the focus on interface lands, and an increased likelihood of invasion of nonnative plants into the treated strips along the boundary and road edges, further affecting the overall integrity of these stands. Long-term effects of mechanical treatments on the coastal scrub and chaparral community would be negligible and adverse due to the focus on strips of habitat adjacent to development.

Grasslands. In contrast to Alternative A, the purpose of mechanical treatments under Alternative B would be twofold. A priority would be placed on reducing fire hazards and secondarily on restoring integrity to grassland communities through elimination of nonnative species and management of native encroaching coastal scrub and tree species in some sites. Positive effects resulting from this secondary priority would be limited, since Alternative B would (1) focus on the developed area/urban interface with minimal to no increases in overall habitat continuity and ecological integrity of grasslands, and (2) increase the likelihood of nonnative plant invasions into the treated strips, further affecting the overall integrity of these stands. Therefore, the overall impacts would be similar to that for the coastal scrub and

chaparral vegetation community; short-term adverse minor impacts could result from these actions due to immediate trampling and soil disturbance impacts. Long-term effects of mechanical treatments on grasslands would be negligible and adverse due to the primary focus on the strips of habitat adjacent to development.

Herbaceous Wetlands. Impacts under Alternative B would be the same as under Alternative A.

Riparian Forest and Scrub. Impacts under Alternative B would be the same as under Alternative A.

Native Hardwood Forest. Impacts under Alternative B would be the same as under Alternative A.

Douglas-Fir and Coast Redwood. Mechanical treatments in this community within the WUI and Park Interior FMUs in San Mateo and Marin counties would double from the acreage in Alternative A. (Actions in the Muir Woods FMU are described in the "Actions Common to All Alternatives" discussion above.) There would be an increased focus on removal of understory fuel accumulations including dead and down trees and shrubs and nonnative shrubs (cotoneaster, brooms). These treatments would further reduce the possibility of high-intensity fires facilitated by existing ladder fuel conditions, and most of these mechanical fuel efforts would have follow-up pile burn treatments, further reducing hazards to adjacent developments and to the vegetation itself. Under Alternative B, no prescribed burning would occur in San Mateo County, and mechanical treatments would be the sole means by which vegetation structure within this community is restored and maintained over time. Short-term impacts would be more obvious than within the grassland and coastal scrub/chaparral communities due to the size of equipment used to remove the cut fuel and litter, with increased impacts on soils and understory herbaceous vegetation, resulting in minor adverse effects. Over the long term, the proportion of nonnative species would remain the same due to ongoing mechanical disturbances. There would be a decreased potential for high-intensity burns, and a low but slightly increased potential for restoration of these stands to a more sustainable condition when done in conjunction with mitigation measures. Long-term impacts would be beneficial and negligible to minor.

Nonnative Evergreen Forest. As with Alternative A, mechanical treatments under Alternative B would be focused on this plant community throughout the park, although priority staffing and funding would be in stands adjacent to developed areas, with a lower priority placed on stands isolated within the Park Interior FMU. As a result, restoration of these sites to native vegetation communities (including coastal scrub, native hardwood forests, and grasslands) would be less likely under this alternative, since the native communities could harbor undesirable fuel loads that would have to be managed as well. The use of a phased implementation plan to piece together restored patches could, however, eventually create long-term benefits. Short-term impacts would be minor to moderate and adverse due to ground and soil disturbance, but long-term impacts would be beneficial and negligible to minor, depending on the extent of work on an annual basis, use of mitigation measures, and adherence to an overall phased implementation and site stabilization plan.

Pile Burning

Piles of cut vegetation could be burned following mechanical treatments, and the overall strategy, implementation, mitigations, and effects would be the same as in Alternative A. These piles would be

constructed away from sensitive resources – wet areas, sensitive species habitat, etc. – to prevent impacts from the concentrated heat effects that occur when piles are burned. Piles would be limited in size, and would be burned during seasons when the potential for fire spread and impacts on adjacent native vegetation would be minimal, such as during the fall after the first rains. Pile burns under Alternative B would increase substantially from the number called for under Alternative A, in association with increased mechanical treatments under Alternative B. Pile burning, with applicable mitigations, would result in short-term direct impacts on the underlying soils, with negligible effects. Long-term impacts would be minor and beneficial (same as Alternative A) in that overall vegetation structure and composition would be improved through the removal of nonnative species and the restoration of native species habitat.

Prescribed Burning

The areas that could be treated with prescribed fire under Alternative B are limited to the Park Interior and Muir Woods FMUs in Marin County. The Muir Woods FMU treatments and impacts are described above in the "Actions Common to All Alternatives" section above. Compared to Alternative A estimates (see Table 2-4 in Chapter 2), prescribed burn acres within the Park Interior FMU would increase slightly, with potential actions in the coastal scrub and chaparral, grasslands, native hardwood forest, and Douglas-fir and coast redwood communities. As noted above, the primary focus of prescribed burn treatments would be to manage hazardous fuels in strategic locations closer to the WUI FMU, and adjacent to developments within the park interior areas.

Coastal Scrub and Chaparral. Prescribed fire would be used to reduce fuel buildups and restore and maintain the integrity and continuity of the coastal scrub and chaparral communities in Marin County. There would be a continued effort to reduce the extent and density of nonnative plant species through follow-up to mechanical treatments for Scotch and French broom and nonnative trees, using strategies and mitigations similar to those outlined in Alternative A. Burning would be conducted to manage broom buildup and control the rapid spread of native shrub species into adjacent grasslands. The scrub extent and the nonnative species component within the grassland-scrub transition would be reduced over time. Individual nonnative, historically significant trees or small groves may be included in the burn unit though limbed up to protect the canopy and prevent tree mortality. Alternative B, unlike Alternative A, would allow burning within the limited chaparral community in Marin County. This could have short-term moderate-to-major beneficial impacts on the fire-adapted species within the chaparral if burns were implemented to best meet the regeneration requirements of these species. Since the continually increasing fuel load within the chaparral stands along Bolinas Ridge and near Muir Woods would eventually support a planned or unplanned ignition, and the vegetation within these stands would recover according to their species-specific adaptations, the long-term impacts of allowing prescribed burns would have a minor beneficial impact on chaparral. Overall, the actions proposed under Alternative B would have long-term minor beneficial effects on coastal scrub and chaparral communities in Marin County, but restrictions on prescribed burning in San Mateo County under Alternative B would result in long-term negligible benefits parkwide.

Grasslands. Prescribed burns could occur only in the Marin County grasslands in Alternative B. Therefore, isolated stands of native perennial grasses – such as purple needlegrass – in San Mateo County

would continue to be affected by encroaching native coastal scrub species and nonnative shrubs, forbs, and grasses. Nonnative patches of Harding and African rice grasses would either remain untreated or would require treatment with mechanical or chemical methods, with associated impacts on soils and adjacent native species. Efforts to study the effects of prescribed burns on specific species and grassland communities in Marin County would continue, however, and would ideally be applied to future planning efforts more inclusive of the park's grassland ecosystems at Sweeney and Milagra Ridges. All applicable mitigation measures would be applied to these burns, including continued monitoring, adherence to site-specific prescriptions, development and analysis of specific burn objectives, and alteration of prescriptions based on those monitoring results. Prescribed burn actions in the grassland community would result in a long-term negligible beneficial impact because of the increased extent of grassland species and control of specific nonnative species in Marin County. Continued studies and adjustment of burn prescriptions could result in moderate beneficial long-term impacts on this community in later years.

Herbaceous Wetlands. Impacts under Alternative B would be the same as under Alternative A.

Riparian Forest and Scrub. Impacts under Alternative B would be the same as under Alternative A.

Native Hardwood Forest. Hardwood forests in the Marin County Park Interior FMU would receive limited prescribed burning under Alternative B. These actions would occur only where such forests border developed or wildland urban interface areas and where these actions would reduce fuel loads or help control nonnative plant species, or within the Muir Woods FMU discussed above. Prescribed fire effects on the native hardwood forests under Alternative B would have negligible beneficial long-term impacts on these forests due to the limited potential extent of area to be treated.

Douglas-fir and Coast Redwood. Although this vegetation type occurs in both Marin and San Mateo counties, only stands in Marin County would be treated under Alternative B. Extant stands at the Phleger Estate would continue to grow without the benefits of understory clearing and forest litter recycling that occurs with prescribed fires. Prescribed burn implementation in the Muir Woods FMU is described in the "Actions Common to All Alternatives" section above. Remaining stands in Marin County outside of Muir Woods would experience long-term negligible-to-minor beneficial effects due to the limited nature of the areas available for burning, their relative isolation and lack of overall habitat continuity, and lower priority for treatment based on the development focus of this alternative. Overall, the impacts would be minor and adverse for this community parkwide, due to the exclusion of stands in San Mateo County.

Research

As under Alternative A, research projects would examine the role of fire in enhancing natural resources and the effects of fire on key natural resources to determine the effectiveness of various treatments. For example, research burns on Harding grass and Scotch and French broom would continue helping ecologists refine burning prescription parameters to control these species and creating the potential for substantial benefits to the park's native coastal scrub and grassland communities. Research into the effects of fire on SOD could potentially help manage this nonnative pathogen and reduce its impacts on bays and tan oaks in the native hardwood Douglas-fir and coast redwood forests of the park. Alternative B only allows for burning within Marin County in the Park Interior and Muir Woods FMUs, and in San Francisco for specific objectives of recovery plans for listed threatened or endangered plant species,

limiting applicable research questions. The overall impacts of research on vegetation communities under Alternative B would be long-term and minor benefits.

Cumulative Impacts

Vegetation at GGNRA has been affected by past fire suppression actions, urban development and loss of habitat continuity, and the establishment and overall dominance of many areas by nonnative plant species. Current and reasonably foreseeable future actions positively affecting vegetation in the park are activities such as the Big Lagoon, Redwood Creek, and mission blue butterfly habitat restoration projects. These projects take into account the natural processes of these sites and are incorporating nonnative plant removal and reestablishment of native plant communities into the project objectives. Potentially adverse impacts could occur with development projects both within the park and adjacent to park boundaries, since they involve ground disturbance activities that could add to or exacerbate existing nonnative plant problems along road and trial corridors. However, ongoing efforts to mitigate these impacts through pre-project weed control, post-project planting and weeding, and use of weed-free products (soils, fill material, and clean equipment) would reduce negative impacts.

Conclusion

As with Alternative A, unplanned wildfires and their suppression could have minor, short-term adverse or beneficial impacts on vegetation. Benefits may result from stimulation of fire-adapted native species or from the destruction of nonnatives. Adverse impacts would result from the loss of native species with subsequent invasion by nonnative species, as well as from crushing, removal, or other physical impacts of suppression actions.

The increased mechanical fuel treatments (and associated pile burning) that would occur with Alternative B would have negligible-to-minor beneficial long-term impacts on the affected vegetation communities overall, as compared to Alternative A. Beneficial effects would be minimized due to the focus of this alternative on developed and wildland urban interface areas, with the potential for creating “strips” of treated vegetation rather than larger, continuous, ecologically sustainable stands, particularly within the coastal scrub and grassland communities. In the forest communities, the long-term proportion of nonnative species would remain the same due to ongoing mechanical disturbances. There would be a decreased potential for unnaturally high-intensity wildland fire, and a low but slightly increased potential for restoration of these stands to more sustainable conditions. Long-term impacts would be beneficial and negligible to minor.

The prescribed burn actions proposed under Alternative B would have long-term minor beneficial effects on coastal scrub, chaparral, and grassland communities in Marin County. Prescribed fire effects on the native hardwood forests under Alternative B would have negligible beneficial long-term impacts on these forests due to the limited potential extent of area to be treated. Continued studies and research, along with adjustment of burn prescriptions, could result in moderate beneficial long-term impacts in later years and would increase these benefits over a wider geographic area. Riparian and wetland areas would be minimally affected under this alternative due to the use of buffers and appropriate mitigation measures. However, the restrictions on using prescribed fire within the WUI FMU or in San Mateo County under

this alternative would minimize long-term benefits, since larger-scale restoration of continuous stands of native vegetation would not be achieved.

Overall, the cumulative effects of past, present, and reasonably foreseeable future actions in conjunction with actions called for under Alternative B would have long-term negligible-to-minor and adverse effects on vegetation, due to the extent of nonnative plant species dominance in many areas of the park, restrictions on fire management actions in many areas of the park (San Mateo County and the WUI FMU for prescribed burning), and more limited geographic extent as compared to Alternative A, with the primary focus on areas with the highest fire risk and limited integration of natural and cultural resource objectives.

Impairment

Overall impacts of Alternative B on vegetation would be slightly adverse. No impairment of vegetation would result.

Alternative C

Mechanical Fuel Reduction

Under this alternative, up to 275 acres of vegetation would be mechanically treated annually. Work would continue, as with Alternative B, in the WUI FMU in Marin, San Francisco, and San Mateo counties, in the Muir Woods FMU in Marin County, and in Marin and San Mateo counties within the Park Interior FMU. Work in the Park Interior FMU would be nearly double that allowed under Alternative B. Hazardous fuel reduction treatments would again include removal of eucalyptus, Monterey pine and cypress, acacia, and other potentially flammable trees along the urban interface, as well as removal of fuel loads threatening the integrity of vegetation or landscapes in more remote areas of the park. Scotch and French broom and other nonnative plant species would be removed. Some soil disturbance would occur during this work due to the use of chipping and hauling equipment, with associated potential for nonnative plant species establishment or spread. Follow-up nonnative plant monitoring would occur on a regular basis with removal of new recruits that come into the site in years following mechanical treatments.

Coastal Scrub and Chaparral. Treatment of coastal scrub and chaparral areas under Alternative C would spread the work effort out to areas where fuel buildups pose both a threat to developments and to the vegetation character of the site (such as from catastrophic fire events or crowding out of native species). The overall number of acres to be treated would be more than double the area treated in Alternative A, and the distribution of those treatment actions would be roughly two-thirds in the WUI FMU and one-third in the Park Interior FMU. Access would continue to be via maintained fire roads. Most actions would be done in conjunction with follow-up pile burns. Under Alternative C, short-term adverse impacts would remain minor (same as Alternative B) due to concentrated trampling and soil disturbance. In setting priorities for and carrying out treatment efforts, however, emphasis would be more on ecosystem health than simply fire hazard abatement, with a focus away from the development strip treatments of Alternative B. This increased opportunity for mechanical treatment (by increasing the number of acres that could be treated annually) and subsequent restoration of habitat continuity and integrity would result in long-term minor beneficial impacts on larger scrub and chaparral stands.

Grasslands. As with Alternative B, mechanical treatments in grassland would be focused on both reducing fire hazards and restoring grassland integrity through the removal of nonnative plant species including Scotch and French broom. The increased opportunities for treating large patches of vegetation under Alternative C would result in short-term adverse negligible to minor impacts from trampling and soil disturbance, with long-term minor-to-moderate beneficial effects.

Herbaceous Wetlands. Impacts under Alternative C would be the same as under Alternative A.

Riparian Forest and Scrub. Impacts under Alternative C would be the same as under Alternative A.

Native Hardwood Forest. Impacts under Alternative C would be the same as under Alternative A.

Douglas-Fir and Coast Redwood. As with Alternative B, mechanical fuel treatments would occur within the Douglas-fir and coast redwood stands with a continued focus on removal of understory fuel accumulations, including dead and down trees and shrubs and nonnative shrubs (cotoneaster, brooms). These treatments, paired with follow-up pile burns and the potential implementation of prescribed burns in both Marin and San Mateo counties, would increase the potential for (1) restoration of sustainable forest structure and integrity, (2) minimal nonnative plant species components, and (3) establishment of native understory plant species more characteristic of these stands. Short-term adverse impacts would be negligible to minor due to site disturbance and soil impacts. Long-term impacts on these stands parkwide, however, would be beneficial and minor to moderate, due to the increased availability of all treatment options.

Nonnative Evergreen Forest. As with Alternative A, mechanical treatments under Alternative C would occur in this plant community throughout the park. The focus of efforts under this alternative, however, would be spread out to cover both those stands adjacent to developed areas as well as treatments within isolated stands in the Park Interior FMU. As a result, restoration of these sites to appropriate self-sustaining native vegetation communities (including coastal scrub, native hardwood forests, and grasslands) would be more likely under this alternative than under either Alternatives A or B. The larger number of acres of allowable treatment under this alternative would speed up overall restoration efforts, which would result in greater short-term minor-to-moderate adverse impacts due to ground and soil disturbance. Long-term impacts would be beneficial and minor to moderate since this alternative would allow for consistent treatment of these nonnative stands over the lifetime of the FMP, taking into consideration both natural and cultural resource values.

Pile Burning

Piles of cut vegetation could be burned following mechanical treatments, and the overall strategy, implementation, mitigations, and effects would be the same as in Alternative A. These piles would be constructed away from sensitive resources – wet areas, sensitive species habitat, etc. – to prevent impacts from the concentrated heat effects that occur when piles are burned.

Piles would be limited in size, and would be burned during seasons when the potential for fire spread and impacts on adjacent native vegetation would be minimal, such as during the fall after the first rains. Due to increased mechanical treatments, pile burns under Alternative C would increase substantially from the

number called for under Alternatives A or B. Pile burning, with applicable mitigations, would result in short-term direct impacts on the underlying soils, with negligible effects. Long-term impacts would be minor-to-moderate and beneficial in that larger vegetated areas would be improved through the removal of nonnative species and the restoration of vegetation continuity and native species habitat.

Prescribed Burning

The areas that could be treated with prescribed fire under Alternative C would include all areas and FMUs of the park except San Francisco, and the number of potential acres that could be treated annually would be substantially higher than under the other alternatives. (The Muir Woods FMU treatments and impacts are described above in the "Actions Common to All Alternatives" section.) The opportunity for conducting small-scale research burns and studies within the WUI FMU, in conjunction with larger broadcast burns in the Park Interior FMU, would help create a more seamless blend of management strategies across vegetation types rather than along management zone boundaries. Potential prescribed burn actions would occur in the coastal scrub and chaparral, grassland, native hardwood forest, and Douglas-fir and coast redwood communities.

Coastal Scrub and Chaparral. Prescribed fire would be used to manage coastal scrub and chaparral communities within both Marin and San Mateo counties. There would be an increased effort to reduce the extent and density of nonnative plant species, where possible, through a combination of management actions including burning. For example, mechanical treatments for Scotch and French broom and nonnative tree removal could be followed up with broadcast burns, where appropriate, using strategies and mitigations similar to those outlined for Alternatives A and B. Alternative C would also allow burning within the park's small chaparral stands, with short-term moderate-to-major beneficial impacts on the fire-dependent species. The broader flexibility of treatment options (size, location, and extent), and the dual focus of treatment rationale under Alternative C would result in long-term moderate beneficial effects within the coastal scrub and chaparral communities parkwide.

Grasslands. Prescribed burns could occur on grasslands in both Marin and San Mateo counties under Alternative C, and the actions and approaches would be similar to the actions described for Alternative A. The larger number of total acres of annual burning under Alternative C would translate to the potential for increased acres of grassland treatments under this alternative, as compared to Alternative A, with the potential for larger gains in nonnative plant species control and eradication, removal of encroaching scrub species, retention of larger intact stands of grassland unconfined by the FMU boundary restrictions of Alternative B, and an opportunity to conduct additional research to answer species-specific or habitat-specific restoration questions. The overall effects of Alternative C on grasslands within the park would therefore be long-term, beneficial, and moderate to major.

Herbaceous Wetlands. Impacts would be the same as under Alternative A.

Riparian Forest and Scrub. Impacts would be the same as under Alternative A.

Native Hardwood Forest. The park's native hardwood forests, which are found throughout the park in the WUI, Park Interior, and Muir Woods FMUs, could be treated through a combination of actions under Alternative C. Specific burns could occur with objectives to restore forest structure and integrity through

the removal of nonnative species, unnaturally high fuel loads, and restoration of fire as a process within the forest understory. In contrast to Alternative A, these actions would not be restricted to areas of hardwood forest adjacent to broom stands or grasslands, and would therefore offer the potential to create a richer mosaic of vegetation communities transitioning from Douglas-fir and redwood forests at more mesic sites to coastal scrub and grassland ecotones at drier sites. The opportunity to use a broader range of management actions within this community and apply those actions to more areas of the park would have long-term minor-to-moderate beneficial impacts on these forests.

Douglas-fir and Coast Redwood. The inclusion of prescribed burning as an option for treatment and management of the Douglas-fir and coast redwood stands in San Mateo County, in addition to those in Marin County, would increase the ecological integrity of this limited community in the park. (Prescribed burn implementation in the Muir Woods FMU is described in the "Actions Common to All Alternatives" section above.) Extant stands at the Phleger Estate would benefit from phased implementation of burns to clear understory fuels, recycle forest litter, and restore or create natural stand structure. The overall impacts of Alternative C would be long-term, minor to moderate, and beneficial.

Research

As with Alternatives A and B, research burns would examine the role of fire in enhancing natural resources and the effects of fire on key natural resources to determine the effectiveness of various treatments. Research on a variety of nonnative species would continue, helping ecologists refine burning prescription parameters that could help control these species. Research could also be conducted throughout the park to investigate the effects of fire treatments on the SOD pathogen, with possible reductions in SOD's impacts on the native hardwood, Douglas-fir, and coast redwood forests of the park. Research opportunities under this alternative would include the WUI FMU, with the potential for investigation, for example, into the effects of buildup (and control of) native soil pathogens on special status species that occur within this management unit, and small research burns in San Francisco in support of federally listed threatened and endangered species. The overall impacts of research on vegetation communities under Alternative C would be long-term, beneficial, and minor.

Cumulative Impacts

The vegetation at GGNRA has been affected by past fire suppression actions, urban development and loss of habitat continuity, and the establishment and overall dominance in many areas by nonnative plant species. Current and reasonably foreseeable future actions positively affecting vegetation in the park are activities such as the Big Lagoon, Redwood Creek, and mission blue butterfly habitat restoration projects, as well as ongoing park operations of the Habitat Restoration Team and Site Stewardship Program. These projects and programs take into account the natural processes of treated sites and incorporate nonnative plant removal and reestablishment of native plant communities into site objectives. Potentially adverse impacts could occur with development projects both within the park and adjacent to park boundaries, since they involve ground disturbance activities that could add to or exacerbate existing nonnative plant problems along road and trial corridors. However, ongoing efforts to mitigate these impacts through pre-project weed control, post-project planting and weeding, and use of weed-free products (soils, fill material, and clean equipment) would reduce negative impacts. The overall cumulative impact on

vegetation with past, present, and reasonably foreseeable future actions both in and adjacent to the park would be minor, long-term, and beneficial.

Conclusion

Unplanned wildfires and associated suppression activities would have minor, short-term adverse or beneficial impacts on vegetation, depending on the vegetation community in which the fire occurred, the timing of the event, and the immediate and long-term impact mitigation measures applied to the site.

The substantially increased potential for mechanical fuel treatments (and associated pile burning) that would occur with Alternative C (as compared to Alternatives A or B) would have minor beneficial long-term impacts on the affected vegetation communities overall. These beneficial effects would be applied to all areas of the park as appropriate, and would integrate both natural and cultural resource values into management of the vegetation, rather than focusing simply on the developed and wildland urban interface areas of the park. In the forest communities, there would be a decreased potential for unnaturally high-intensity burns, and a moderately increased potential for restoration of these stands to more sustainable conditions. Long-term impacts would be beneficial and minor.

The prescribed burn actions proposed in Alternative C, in conjunction with mechanical and pile burn treatments, would have long-term minor-to-moderate beneficial effects on the coastal scrub, chaparral, and grassland communities. There would be a greater potential for creation and maintenance of continuous ecologically sustainable stands, and an increased opportunity for larger-scale restoration of continuous stands of native vegetation. Prescribed fire actions on the native hardwood forests in Alternative C would increase the potential to create a richer mosaic of vegetation communities. The opportunity to use a broader range of management actions within this community, and apply those actions to more areas of the park would have long-term minor-to-moderate beneficial impacts on these forests. Continued studies and research, along with adjustment of burn prescriptions, would result in moderate beneficial long-term impacts throughout the park in all affected vegetation communities. As in Alternatives A and B, riparian and wetland areas would be minimally affected under this alternative due to the use of buffers and appropriate mitigation measures.

Overall, the cumulative effects of past, present, and reasonably foreseeable future actions in conjunction with actions called for under Alternative C would have long-term minor-to-moderate beneficial effects on vegetation.

Impairment

The overall impacts of Alternative C on vegetation would be beneficial and would not result in impairment of vegetation.

Impacts on Wetlands

Analysis

The major adverse impacts of fire management activities on wetlands include sedimentation, hydrological alteration, soil compaction, disturbance of vegetation, and contamination by saltwater, herbicides, or fire

retardant. Beneficial impacts of fire on wetlands include the continuation of natural processes as well as the eradication of nonnative species.

Sedimentation can occur when fire activities upslope of the wetland result in erosion. Excess sediment levels in a wetland can adversely affect the wetland by altering the hydrology and in turn the vegetation composition. These effects could be major and permanent depending on the percentage of the wetland that is affected.

Increased runoff from compacted or hydrophobic soils upstream could affect wetland hydrology by causing scour or forming new drainage channels that deplete the site of water. This may lead to a change in the hydrology, soils, and vegetation of the site that could be both major and permanent.

Soil compaction requires special consideration in wetlands, since wetlands have wetter soils year-round. Fire management activities such as cutting hand line or dozer line in wetlands can be very destructive if conducted when soils are wet. Soil compaction could lead to a change in the hydrology of the site, but would likely affect only a portion of the site and thus be considered moderate in intensity.

Wetland vegetation can be affected by burning or vegetation removal activities. A certain degree of burning through a wetland could be beneficial, since wetlands are included in a landscape that has evolved with fire. Research described by the Point Reyes National Seashore (PRNS) FMP (2004) suggests that, if burned areas retain seed of native species in the soil, or if burns create a mosaic pattern with some surviving native vegetation or resprouting native vegetation, within a few years it can be difficult to determine that a fire recently occurred. However, high-intensity impacts such as an uncontrolled fire or disruptive fire lines through a wetland could make the area more susceptible to invasion by nonnative plants.

Impacts from fire management actions could also occur during fire suppression from aerial drops of saltwater into freshwater wetlands or the use of foam or wetting agents. These could have the effect of killing salt-intolerant plants or smothering vegetation with fire retardant. These effects would likely be short-term and minor, except if the area is subsequently invaded by nonnative species that present a long-term threat to native vegetation.

Actions Common to All Alternatives

Wildland-Urban Interface Initiative

The cooperative Wildland-Urban Interface Initiative would continue under all the alternatives, and would consist of reducing fuels along the park boundary. Mechanical removal of trees and brush in the upper reaches of the watersheds could create soil compaction and erosion that increase surface flow and sedimentation in the lower-lying wetlands. These effects would be localized and minor, and with the applicable mitigation measures listed in Chapter 2 would be negligible.

Defensible Space/Vegetation Clearing Around Structures

Mechanical removal of trees and brush throughout the watersheds could create soil compaction and erosion that increase surface flow and sedimentation in the lower-lying wetlands. These effects would be localized and minor, and with the applicable mitigation measures listed in Chapter 2 would be negligible.

Roadside Fuel Reduction

Maintenance or upgrading of fire roads could create ground disturbance and runoff and cause a sedimentation problem in wetlands. However, many fire roads in the park are currently in substandard condition, and maintenance activities and drainage improvements could actually correct a current problem. With current best management practices (BMPs) for the maintenance of fire roads and trails incorporated, these activities would have a beneficial, long-term, and minor effect on wetlands.

Suppression

The potential impacts of wildland fire suppression on wetlands are similar to potential impacts of wildland fire suppression on other vegetation classes as described in the previous section (see discussion under "Impacts on Vegetation" above). Due to increased moisture levels often present in wetlands, however, such impacts can be more severe.

GGNRA has had an average of 8 unplanned fires annually, with each fire generally burning less than 5 acres. The impacts on wetlands associated with these small unplanned wildfires and their suppression are expected to be both adverse and beneficial. Adverse impacts are expected to be minor and short-term. It is possible that small invasions of nonnative plants would result from these fires, which could result in a longer-term impact, but the impact would be localized. Small unplanned wildland fires in the project area may have some beneficial impact on wetlands in localized areas if nonnative plants are killed and native plants establish on the site following the fire.

Suppression activities would also have direct but localized impacts. Fire control lines can involve clearing all vegetation within an 18- to 24-inch-wide swath down to bare mineral soil. In emergency situations, bulldozers can be used to create fuel breaks to stop wildfire. Vegetation clearing can disturb wetland soils as well as create conditions that are favorable for the establishment of nonnative plant species.

Aerial drops of water or retardant are means of releasing liquids onto burning or unburned areas. Although the chemical components of retardant only remain for a few months at most, and long-term, chemical alteration of the soil would not occur, there could be localized long-term impacts on areas if nonnative plants become established or spread.

These effects on wetlands would be minor, short-term, and adverse. However, if the applicable mitigation measures listed in Chapter 2 are applied during or following suppression, the wetland could receive a beneficial, long-term, and minor effect from the wildland fire.

Treatment of Muir Woods FMU

Prescribed fire, mechanical thinning, and understory thinning would occur in Muir Woods FMU in all the alternatives. These projects could affect wetlands adjacent to Redwood Creek through sedimentation, compaction, and disturbance of vegetation. This would create an adverse, short-term minor effect. However, prescribed burning could have a beneficial impact on wetlands by maintaining the natural processes of the watershed. Likewise, mechanical removal of nonnative species such as French broom would prevent encroachment of these species into wetlands.

If the applicable mitigation measures listed in Chapter 2 are followed for actions at Muir Woods FMU, there would be beneficial, long-term, minor impacts on the wetlands.

Treatment of San Francisco County Project Area

Fire management activities in San Francisco lands would consist only of mechanical treatment and small research burns for implementation of Recovery Plan objectives for federally listed plant species. Mechanical treatments would avoid wetland areas to the greatest extent possible. If such treatments in wetlands were deemed necessary to ensure fire safety around structures or roads or to remove nonnative vegetation, a buffer would be maintained around wetland areas where fire management activities would be restricted. Staging and vehicle use would occur outside of the buffer area, and nonnative vegetation removal would occur under tightly controlled conditions. Any impacts that occur in the buffer area must be correctable by site-specific actions, and must be confined to short-term, minor (or less), adverse effects. In many cases, clearing of dense nonnative vegetation could result in increased growth or establishment of native wetland species by creating gaps or openings in canopy cover. These impacts would be considered beneficial, minor, and long-term.

Unplanned fires in San Francisco would be suppressed immediately. Fire suppression activities, as described above, could have adverse, short-term, minor effects on wetlands.

With the applicable mitigation measures listed in Chapter 2, fuel reduction measures in San Francisco lands would result in beneficial, minor, and long-term effects on wetlands.

Public Information and Fire Education Programs

The public information and education program would have no beneficial or adverse effects on wetlands.

Fire Cache

Fire cache relocation would have no beneficial or adverse effects on wetlands.

Fire Effects Monitoring

The fire effects monitoring program excludes wetlands from analysis since these habitats are not targeted for treatment with prescribed fire. Therefore, negligible impacts on wetlands would occur with continued implementation of this program.

Alternative A

Mechanical Fuel Reduction

Alternative A allows for a maximum of 100 acres of mechanical treatments throughout the park. Mechanical treatment would be focused near structures or high-value areas, largely through the Wildland-Urban Interface Initiative. Mechanical treatments would avoid wetland areas to the greatest extent possible to minimize adverse impacts on soils, hydrology, and vegetation. If such treatments in wetlands were deemed necessary to ensure fire safety around structures or roads or to remove nonnative vegetation, a buffer would be maintained around wetland areas where fire management activities would be restricted. Staging and vehicle use would occur outside of the buffer area, and nonnative vegetation removal would occur under tightly controlled conditions. Any impacts on wetland soils, hydrology, or vegetation that

occur in the buffer area must be correctable by site-specific actions, and must be confined to short-term, minor (or less), adverse effects. In many cases, clearing of dense nonnative vegetation could result in increased growth or establishment of native wetland species by creating gaps or openings in canopy cover. These impacts would be considered beneficial, minor, and long-term.

With the applicable mitigation measures listed in Chapter 2, the impacts on wetlands from mechanical treatments under Alternative A would be beneficial, long-term, and minor.

Pile Burning

Most mechanical removal projects would include pile burning. The piles would be small in size and create very localized compaction and hydrophobic soil. The piles would not be located in wetlands, and would otherwise have a negligible impact on the park's wetlands.

Prescribed Fire

This alternative focuses on prescribed burning for resource management, but does not specify wetlands as a target resource. Seasonal wetlands are often located adjacent to grasslands and scrub communities throughout the park, and therefore could be affected by prescribed burns in these plant communities. These would be low- to moderate-intensity burns, which generally burn near or around moist wetland soils rather than in the wetlands themselves. If burns are prescribed in the summer or fall, when seasonal wetlands are dry, some impact from the loss of vegetation is possible. In dry years, prescribed fire may burn into perennial wetlands as well.

In general, a buffer would be maintained around wetland areas where fire management activities would be restricted. Staging, fire line construction, and vehicle use would occur outside of the buffer area, and prescribed burning inside the buffer area would occur under tightly controlled conditions. Any impacts on wetland soils, hydrology, or vegetation that occur in the buffer area must be correctable by site-specific actions, and must be confined to short-term, minor (or less), adverse effects. The sites will be monitored after prescribed burning to ensure that the species composition favors native wetland species and does not promote the growth of nonnative species.

Under these circumstances, the prescribed burns would have minor-to-moderate long-term beneficial impacts on wetland vegetation by stimulating growth and reproduction of native wetland species. Even if the wetland vegetation was too wet to burn, the wetland would benefit from native plant stimulation in the surrounding buffer area. One benefit would be a reduced chance of encroachment by nonnative plants into the wetland area.

By following the applicable mitigation measures listed in Chapter 2 during prescribed burning, the impacts on wetlands from Alternative A would be beneficial, long-term, and moderate.

Research

Alternative A could include elements of research into the effects of fire on vegetation, hydrology, soils, and other features. It is possible that some research could focus on the effects of fire on wetlands. If this is the case, there is a chance that the research could show that fire has an adverse effect on wetlands. These

effects, however, would likely be short-term and minor. Research would more likely show that fire has a beneficial effect on wetlands by maintaining the natural processes in the wetlands.

The applicable mitigation measures listed in Chapter 2 would ensure that only short-term, minor effects occur as a result of fire effects research.

Cumulative Impacts

As previously described in this chapter, cumulative impacts are those that would occur not only as a direct result of this planning effort or actions proposed under the alternative, but in conjunction with other activities within the same project areas. These projects should be considered when developing fire management plans for the various project areas. The combined impacts of unrelated projects and fire management activities within a project area should not exceed the threshold for minor impacts on wetlands (i.e., changes in the areal extent, or in wetland vegetation, soils, or hydrology, would be measurable but would affect less than 5 percent of the total extent of the wetland type in the project area). For example, the Big Lagoon restoration in the Redwood Creek watershed is a large-scale restoration that could temporarily disrupt wetland function in the area while natural processes are restored. Fire management planning for the upper reaches of the watershed should create only minor impacts such as erosion and sedimentation so that the wetland restoration is successful. Similar consideration should be given to any transportation, trail improvement, maintenance, habitat restoration, or other project that creates sedimentation or other impacts on wetlands.

Conclusion

Fire management activities would avoid wetland areas to the greatest extent possible to minimize adverse impacts on soils, hydrology, and vegetation. If such treatments in wetlands were deemed necessary to ensure fire safety around structures or roads or to remove nonnative vegetation, an appropriate buffer would be maintained around wetland areas where fire management activities would be restricted. Staging and vehicle use would occur outside of the buffer area, and nonnative vegetation removal would occur under tightly controlled conditions. Any impacts on wetland soils, hydrology, or vegetation that occur in the buffer area must be correctable by site-specific actions, and must be confined to short-term, minor (or less), adverse effects.

Mechanical treatments and prescribed fire could have adverse, short-term, minor impacts on wetland soils, hydrology, and vegetation. Overall, the fire management activities would have minor-to-moderate long-term benefits to wetland communities through reduction of nonnative plant species and stimulation of growth in native species. Furthermore, the minor adverse impacts could be offset by the beneficial effect of preventing a large-scale wildfire. An unplanned, excessively hot fire could have major, long-term, adverse impacts on wetlands by destroying vegetation and allowing invasion by nonnative species, creating hydrophobic soils, and increasing runoff.

Impairment

No impairment of wetlands would result from this alternative.

Alternative B

Mechanical Fuel Reduction

Alternative B relies largely on mechanical fuel reduction throughout the park, particularly in the WUI FMU. Although the total acreage of projects per year would be greater than under Alternative A, the impacts would not be significantly different. With the implementation of the mitigation measures described for Alternative A, and in Chapter 2, the impacts on wetlands from mechanical removal under Alternative B would be beneficial, long-term, and minor.

Pile Burning

Impacts would be the same as under Alternative A.

Prescribed Fire

Under Alternative B, prescribed burning would occur in the Park Interior FMU, and Muir Woods FMU, covering a maximum of 120 acres per year throughout the park. This would be a level of impact similar to Alternative A. With the implementation of the mitigation measures described for Alternative A, the effects of prescribed fire on wetlands under Alternative B would be beneficial, short-term, and minor.

Research

Impacts would be the same as under Alternative A.

Cumulative Impacts

Impacts would be the same as under Alternative A.

Conclusion

Impacts would be the same as under Alternative A. Mechanical treatments would avoid wetland areas to the greatest extent possible. If such treatments in wetlands were deemed necessary to ensure fire safety around structures or along roads, these treatments would have negligible-to-minor adverse impacts on wetland vegetation, hydrology, and soils. Clearing vegetation also could have minor benefits to wetland species if native species establishment is enhanced.

Minor adverse impacts are possible from prescribed fires burning near and into wetlands in dry years. If fire intensity is low to moderate, minor-to-moderate benefits on wetland vegetation are possible due to reduction of nonnative plant species or stimulation of germination and resprouting in native species.

These minor adverse impacts could be offset by the beneficial effect of preventing a large-scale wildfire. An unplanned, excessively hot fire could have major, long-term, adverse impacts on wetlands by destroying vegetation and allowing invasion by nonnative species, creating hydrophobic soils, and increasing runoff.

Impairment

No impairment of wetlands would result from this alternative.

Alternative C

Mechanical Fuel Reduction

Alternative C would involve more mechanical fuel reduction in Marin County, with the same acreages in San Francisco and San Mateo counties as Alternative B. The increased acreage in Marin would occur in the park interior areas. Although the total acreage of projects per year would be greater than under Alternatives A and B, the impacts would not be significantly different. With the implementation of the mitigation measures described for Alternative A and in Chapter 2, impacts on wetlands under Alternative C would be beneficial, long-term, and minor.

Pile Burning

Impacts would be the same as under Alternative A.

Prescribed Fire

Under Alternative C, prescribed burning would occur mainly in the Park Interior FMU, with a limited amount in the WUI FMU and Muir Woods FMU. A maximum of 320 acres per year would be burned throughout the park. While this is an increase in acreage from Alternatives A and B, the intensity of impact would not exceed minor. With the implementation of the mitigation measures described for Alternative A, the effects of prescribed fire on wetlands under Alternative C would be adverse-to-beneficial, long-term, and minor.

Research

The adverse impacts of this alternative would be similar to those of Alternatives A and B. However, the beneficial impacts could be increased due to the opportunity for more research burns.

Cumulative Impacts

Impacts would be the same as under Alternative A.

Conclusion

Impacts would be the same as under Alternative A. Mechanical treatments would avoid wetland areas to the greatest extent possible. If such treatments in wetlands were deemed necessary to ensure fire safety around structures or along roads, these treatments would have negligible-to-minor adverse impacts on wetland vegetation, hydrology, and soils. Clearing vegetation also could have minor benefits to wetland species if native species establishment is enhanced.

Minor adverse impacts are possible from prescribed fires burning near and into wetlands in dry years. If fire intensity is low to moderate, minor-to-moderate benefits on wetland vegetation are possible due to reduction of nonnative plant species or stimulation of germination and resprouting in native species.

These minor adverse impacts could be offset by the beneficial effect of preventing a large-scale wildfire. An unplanned, excessively hot fire could have major, long-term, adverse impacts on wetlands by destroying vegetation and allowing invasion by nonnative species, creating hydrophobic soils, and increasing runoff.

Impairment

No impairment of wetlands would result from this alternative.

Impacts on Wildlife and Important Habitat

Analysis

Wildlife impacts from fire management actions primarily involve modifications of habitat and disturbance from actions, such as noise from mechanical removal of trees. Quantifying or accurately predicting the effects of wildfire and prescribed burns is difficult because fire is inherently unpredictable. For example, fire intensity (which strongly influences the degree of impacts) varies substantially in response to the season, wind speed, air temperature, relative humidity, composition of fuels, topography, and other parameters. Because of the inability to predict the nature of wildland fires, this analysis of the effects of wildfire on wildlife is qualitative. The effects of prescribed burning on wildlife are somewhat more predictable and easier to mitigate through careful planning and implementation; nonetheless, credible scientific data on such effects in the planning area are limited.

Generally, the effects depend on the characteristics of the fire management actions (e.g., intensity of fire, duration of activity, frequency, size, shape, season, and time); the characteristics of the vegetation or habitat treated or affected; and species characteristics (e.g., size, mobility, and habitat preferences). Modification of habitat, including breeding sites, food resources, water sources, and cover, are factors that determine whether wildlife populations persist, thrive, or decline in response to fire actions. Changes in the structure and composition of understory and overstory vegetation, as well as resultant changes in microclimates within and adjacent to fire treatment units, will affect wildlife species (McMahon and deCalesta 1990).

The impacts of fire management actions on wildlife can be direct or indirect. Direct impacts include incineration, asphyxiation, injury, disturbance from noise or movement, and/or avoidance of an area. Direct injuries and death from fire management actions may primarily affect less mobile species or life stages. Wildlife may also experience indirect effects from fire actions. For example, fish or aquatic invertebrates can be harmed by sedimentation in a creek due to post-fire soil erosion, or carnivores can suffer from reductions in the prey base as a result of either direct mortality of the prey or a reduction in the food and cover resources used by the prey species.

Habitat loss is a possible adverse indirect impact from fire management actions that can be short- or long-term in duration. Changes in vegetation structure and composition, down and dead woody material, and snag availability that occur due to fire management actions can all affect wildlife. In particular, the loss of down and dead woody material and snags during a prescribed burn removes essential structural habitat components for a variety of wildlife and reduces species diversity (McMahon and deCalesta 1990). Depending on the season, fire actions can also have adverse effects on a species' nesting or reproductive success. The nature of the action (e.g., the intensity and size of a controlled burn or the area of mechanical tree removal) will also determine whether ground-dwelling or canopy-dwelling species are affected. Fire management actions that are larger in area and involve more complete habitat modification could affect entire populations or subpopulations of wildlife.

Wildlife would also benefit from fire management actions as most native species evolved in ecosystems within the park that were subject to periodic fire. For instance, populations of species dependent on early seral stage vegetation may increase following a burn or mechanical treatments. Vegetation that grows in the first two to ten years after a burn often contains higher levels of nitrogen, offering higher quality forage for herbivores. In addition, decreased cover associated with mechanical removals and prescribed fire can improve the growth of forage and can improve predator hunting success. Enhanced foraging opportunities may lead to decreased parasite loads and increased dispersion, which may reduce the spread of some diseases. Fire management actions can either increase or decrease the availability of tree snags that are used by many species for nesting, shelter, and foraging. However, management actions can be planned to leave snags in place or create new snags. Mechanical removal of nonnative trees and weeds and any associated follow-up seeding or planting would enhance native plant communities, providing better habitat for native wildlife. For example, native oak trees provide many wildlife species with the important resource of acorns. In addition, prescribed fire and/or mechanical treatments could be used to enhance disturbance-adapted plant communities and the wildlife that they support.

Fire management actions that are patchy – those that result in a mosaic of treated and untreated areas and those that differ in intensity – will maintain heterogeneous environments that support a broad faunal diversity. A primary goal of the GGNRA FMP is to avoid high-intensity, stand-replacing fires, which become more likely with increased fuel loads. Intense, hot fires can change vegetation types (e.g., a forest to brush/grassland or native coastal scrub to nonnative shrubs lower in wildlife habitat values) over large areas, or the areas may take decades to recover. Patchy, low-intensity fire management actions would not dramatically alter landscapes, allowing the remaining untreated native vegetation to continue providing habitat for existing wildlife. Impacts from these actions would tend to be relatively minor and short-term. Lack of fire and the resultant late seral stage vegetation encourage species that thrive in such environments (see subsections on each class of wildlife below) at the expense of species favoring early or mid-seral habitats. Evidence suggests that maintenance of a variety of successional stages that mimic the natural patchy patterns of fires of GGNRA would ensure the highest levels of wildlife biodiversity (Nichols and Menke 1984).

Mammals

Adverse impacts on mammals from fire management actions would largely be associated with vegetation change and disturbance. Most mammals are capable of escaping immediate injury or death from fire management actions because of their mobility. Seventeen species of bats, four of which are federally sensitive species, are known to occur in the park, with some species making use of tree cavities, fire scars, and loose bark for roosting. Fire actions that destroy maternity roosts may have substantial impacts on bats because of their low reproductive rates. Some species of rodents, including the western harvest mouse, brush mouse, and woodrat species, are known to decrease after stand-replacing fires (Schwilk and Keeley 1998). Other species, including pocket gophers and deer mouse species increase after fires (Sims and Buckner 1973, Kaufman et al. 1988). Carnivores that depend on any of these species as prey would be similarly affected. Reduced vegetation cover associated with most of the fire management actions would increase risks for prey species while potentially increasing hunting opportunities for predators. Some small mammals would benefit from increased availability or foraging efficiency for seeds with reduced vegetation. During the first few growing seasons after a fire, improved vegetation growth usually

provides increased food for herbivorous mammals (Ahlgren and Ahlgren 1960). Black-tailed deer would benefit from the increased nutritional quality of recently burned vegetation, with positive impacts decreasing in five or more years post-burn. Prescribed fire and other fire actions may reduce disease rates in mammalian and avian populations by killing ground dwelling parasites and causing dispersion of individual animals, thereby reducing disease transmission (Peek et al. 1985). Brush rabbits, black-tailed deer, and other herbivores are expected to be positively affected by fire and regrowth of vegetation. Dusky-footed woodrats, western harvest mouse shrews, and other small mammals are expected to experience short-term, minor, adverse impacts. The adverse impacts of fire management actions would range from short- to long-term and be minor in intensity due to the limited areas affected. Long-term beneficial impacts would result from fire actions that restore and enhance native plant communities.

Birds

The main effects of fire management actions on birds are changes in habitat and disturbance occurring during the nesting season, March 1 through July 31. Adult birds are highly mobile and can escape direct injury or death from fire management actions, but eggs, nestlings, and recently fledged birds are unlikely to be able to escape these actions. Fire in California shrublands and forests has been shown to maintain or increase avian species diversity, and also to alter species composition. Populations of some species, such as California quail, Swainson's thrush, scrub jay, and certain owls, may decline in the first few years after fire (Lawrence 1966, Lyon and Marzluff 1985). Other species, such as raptors, woodpeckers, and other owl species (burrowing, western screech), have been shown to increase in abundance after fires (USDA 2000). Species adapted to early seral stages would benefit from fire management actions that set back successional processes. Ground-dwelling birds in the park, such as California quail, northern harrier, and savannah sparrow, would be negatively affected in the short term by most fire management actions, but may benefit from patches of more open habitat in the longer term. Canopy-nesters, such as red-tailed hawks, white-tailed kites, sparrow hawks, ravens, and many songbirds, would be affected by tree removals and fires that reach into the canopy. Impacts from prescribed fire and mechanical removals would be long-term and minor as these actions would be conducted outside the nesting season. However, vegetation regrowth would begin within months, and long-term beneficial impacts would result from fire actions that restore and enhance native plant communities. The consequences of fire management actions on snag numbers and their locations would result in variable impacts on cavity-nesting birds and other species of birds that feed on wood-boring insects (USDA 2000). Conducting snag surveys prior to fire management actions would allow for better planning to protect these resources and determination of whether snags should be created as part of a particular project.

Amphibians and Reptiles

Fire management actions have the potential to cause more direct mortality on less mobile species, including amphibians, and some reptiles. Because amphibians and their eggs have evolved in moist environments and often require forest debris as habitat, fire impacts are a consequence of loss of litter and changes in water quality. Reptiles that occupy heat refugia during the day are usually not directly affected by fire. Along with reptiles, most amphibian populations show little response to mixed severity understory fires although species favoring open habitats are clearly favored in the first few years after a fire, before understory and shrub vegetation regenerates (USDA 2000). Because fire actions would be

limited in size and location under the GGNRA FMP, the overall impact on invertebrates, amphibians, and reptiles would be adverse, minor, and short-term. The impact on amphibians would be minor because effects would be localized and non-emergency fire management actions would not take place within 100 feet of riparian areas.

Fisheries and Aquatic Species

For fish, the primary concerns relative to fire are increases in water temperature and sediment, and the long-term loss of woody debris from stream channels. The most long-lasting and severe effects on fish habitat from fire occur when fire is associated with the loss of streamside forest (McMahon and de Calesta 1990). Of concern are the effects of burning in or near headwater channels that facilitate the transport of sediment and debris downslope into fish-bearing streams when stream networks expand during periods of high runoff.

Fire may affect the abundance and diversity of fish habitat and populations in streams by affecting the composition and structure of riparian vegetation and influencing water quality and quantity in a stream (McMahon and deCalesta 1990). Loss of riparian vegetation can lead to elevated water temperatures, reducing the ability of the water to hold dissolved oxygen. However, work in riparian and streamside areas would be carefully managed to ensure that impacts are mitigated to an acceptable level

Invertebrates

At least 44 species of butterflies occur in the Marin Headlands and 34 species occur at Milagra Ridge. Other terrestrial invertebrates are not well inventoried for the park. Fire management actions may have considerable lethal effects on invertebrates in localized areas, because many invertebrates, particularly ground and soil-dwelling species and larval stages of flying invertebrates, are relatively immobile. While most invertebrates that live in the surface soil layers and invertebrate eggs are likely to be killed by prescribed fire, some ants and flying surface insects may increase in numbers after a fire. In addition, fire may create snags, which attract a variety of wood-boring insects. Monarch butterflies (*Danaus plexippus*) make use of nonnative Monterey cypress and pine and eucalyptus trees as overwintering sites, often using the same trees or groves year after year. Overwintering monarchs may be adversely affected by fire actions that remove important clustering sites. Monarch larvae feed almost exclusively on native milkweed plants that may benefit from prescribed fire that preserves grassland areas where it occurs.

Actions Common to All Alternatives

Wildland-Urban Interface Initiative

The emphasis of the Wildland-Urban Interface Initiative at GGNRA is to reduce the density of hazardous fuels that create a risk to lives or property on parklands adjacent to the park boundary. Most projects would continue to focus upon the mechanical removal of nonnative vegetation and highly flammable fuels from areas where parklands adjoin neighboring properties. Removal of nonnatives, followed by application of a strategy promoting the reestablishment of native vegetation, can provide more habitats needed by native wildlife. For example, native species of oak provide both structure for breeding and roosting as well as food sources, such as acorns, which can be a valuable source of forage. Mechanical removals would remove vegetation and disturb soil and forest litter, affecting small mammals, reptiles, amphibians, invertebrates, and terrestrial landbirds. In addition, work crews would be a disturbing

element for wildlife in project areas. Impacts would be adverse, short-term, and minor until the area is revegetated. In the long term, moderate beneficial impacts would be gained as a diversified, native habitat type is reestablished.

Defensible Space/Vegetation Clearing Around Structures

The creation of defensible spaces around structures would remove vegetation and disturb soil and litter, possibly affecting small mammals, reptiles, amphibians, invertebrates, and terrestrial landbirds. However, many of the species found close to buildings, particularly in developed zones of the park, are human-associated and relatively common, as opposed to many sensitive species that are more disturbance-intolerant. Impacts would be adverse, long-term (because treatments would need to be repeated), and minor.

Roadside Fuel Reduction

Fire road maintenance would remove vegetation and disturb soil and litter, possibly affecting small mammals, reptiles, amphibians, invertebrates, and terrestrial landbirds. Maintaining fire roads could have larger impacts than clearing defensible spaces around buildings because some portions of fire roads run through interior sections of the park. Habitat along these road/trail corridors is already disturbed by human activity, however, and may be of lower quality for some species. Impacts would be adverse, long-term (because treatments would be repeated), and minor.

Suppression

Adverse effects on wildlife can result from fire suppression activities, such as construction and use of staging areas, helispots, or spike camps; construction of fire lines using hand tools or bulldozers; cutting of snags; and mop-up. Maintaining control of prescribed fires can also involve hand line construction, snag removal, water drops, and other actions, but such efforts are likely to be much less intense, and have less impact, than they would during wildland fire suppression.

Small species of mammals, reptiles, or amphibians can be injured or killed when vehicles are traveling to sites or staging areas, or when bulldozers are constructing line. It is anticipated that in most cases these impacts would occur infrequently. Removal or trampling of vegetation in temporary staging areas used for suppression activities could adversely affect wildlife until vegetation in such areas regrows. Noise, dust, and light emanating from suppression staging areas could affect the use of surrounding habitats by wildlife. Spills of fuel, oil, hydraulic fluid, antifreeze, and other toxic chemicals at staging areas could affect wildlife, especially those in aquatic environments. Personnel at fire camps or on suppression crews could inadvertently provide food sources to wildlife through improperly disposed garbage, resulting in conditioning of wildlife and in human/wildlife conflicts. These activities and the impacts they cause are discussed in greater detail below.

Dropping water or retardants on fires from helicopter buckets could result in a variety of impacts on wildlife. Water removed from small water bodies could have temporary seasonal impacts on aquatic organisms by reducing the size of wet or wetland habitat, or more serious and possibly permanent impacts on the inhabitants if the pond is completely drained or dried prematurely. Organisms caught when water is obtained are likely to be killed when the water is dropped.

Transfer of water from one area to another can also have impacts on wildlife. For example, in the Sierra Nevada, chitrid fungus has been identified as a factor in the disappearance of mountain yellow-legged frog populations. Federal land management agencies in the region have expressed concern that helicopter buckets dipping in separate water bodies could add to the problem by spreading the fungus to currently noninfected populations of frogs. In GGNRA, the use of multiple water bodies to fight a wildfire could result in the spread of nonnative bullfrogs, which prey heavily on native frog species, or contribute to the spread of unknown pathogens or other nonnative species.

The physical impact of a water drop could adversely affect individual animals through crushing. One advantage of water drops is that in some circumstances they can take the place of hand lines ("wet-lining") to control fire movement. This tactic would result in less impact on soil, forest litter, and vegetation than hand line construction and, therefore, would have less impact on wildlife, both in intensity and duration. Using saltwater for fire suppression actions may harm plants and soils. This could have adverse impacts on wildlife, particularly amphibians and butterflies tied to specific host plants in localized areas. The impact of water drops on wildlife would be adverse, long-term, and minor based upon possible impacts on aquatic ecosystems, especially in relation to amphibians. Impacts from saltwater drops would be short-term, adverse, and minor. The potential impact would be minor because the historic occurrence of unplanned ignitions has been infrequent and most do not involve water drops. If they did occur, however, the impact would be limited to a relatively small area. Water drops are not used in prescribed fire activities at the park.

Retardant drops have the same potential for physical injury as water drops, but may also be toxic, particularly in aquatic habitats. Studies have shown that the ecological effects of retardant and fire suppressant forms can be adverse to algae, aquatic invertebrates, and fish (Hamilton et al. 1996). The low-flying aircraft could also disturb wildlife. The impact on wildlife from retardant drops is expected to be negligible, adverse, and short-term because of their limited application in the park and protocols for their use designed to protect aquatic resources, including applicable mitigation measures.

Construction of helispots can result in the felling of trees and snags, which are potential wildlife habitat. Snags are particularly important wildlife habitat. In addition, the noise from helicopter traffic would likely disturb wildlife, such as nesting raptors. The impact of helispots on wildlife is expected to be adverse, long-term, and minor, since they would likely be used on a very limited basis (if at all). All landing areas would meet the standards outlined in the Interagency Helicopter Operations Guide, and safe landing spots identified in the GGNRA Aviation Management Plan Mitigations would be used. These mitigations, in addition to limiting helispot construction and locating helispots away from sensitive resources, would reduce impacts.

Fire crews staying in spike camps can have an adverse effect on wildlife by providing sources of human food and trash. This could lead to certain wildlife becoming conditioned to human foods, potentially resulting in human-wildlife conflicts. In some cases, habituated animals must be killed to protect human safety. Presence of hand crews in more remote areas also would introduce an element of disturbance, which could affect sensitive species such as nesting raptors. Impacts on wildlife from spike camps are

expected to be adverse, short-term, and minor. However, locating spike camps away from sensitive resources and providing strict control of food and trash at camps can reduce these impacts.

Hand line construction would remove vegetation and disturb soil and forest litter, possibly affecting small mammals, amphibians, invertebrates, and ground-nesting birds. The presence of hand line crews in remote locations could cause direct disturbance of some wildlife species and introduce unnatural food sources (see discussion of spike camps above). Removal of forest litter and vegetation can also lead to soil erosion and increased siltation in adjacent lakes and streams. This could have an adverse effect on aquatic species, including invertebrates, amphibians, and fish. Impacts of hand line construction in association with managed wildland fire and prescribed fire would be adverse, short-term, and negligible given the present limited amount of wildland fire and the limited use for prescribed fire.

Snags provide extremely valuable habitat for some wildlife (Brown and Bright 1997), particularly cavity-nesting birds and mammals. The loose bark also serves as a nesting and roosting site for some species, as well as a foraging site for species that prey upon wood-boring insects. Any suppression actions that require the felling of snags to protect human safety and the integrity of fire lines would potentially affect wildlife by reducing the availability of snags to species such as pileated woodpeckers and several bat species. Felling would likely kill some animals. The number of snags lost would vary, depending upon factors such as the type and age of tree stand, its history of fire and/or disease or insect infestation, and the intensity of the fire. Snag removal associated with fire suppression activities would potentially have minor, long-term, and adverse impacts because of the relatively small areas that would be affected. On the other hand, wildfires often create snags by killing trees.

Mop-up, or the churning of soil and forest litter to extinguish residual hot spots along the periphery of a fire, would cause some mortality of fossorial and semi-fossorial organisms (e.g., broad-footed moles [*Scapanus latimanus*] and Botta's pocket gophers [*Thomomys bottae*]) by exposing them to heat and flames. Such an impact, however, would be along short sections of the lined perimeter and affect few species. The impact of mop-up would therefore be adverse, short-term, and negligible for both prescribed burn and wildfires.

Treatment of Muir Woods FMU

Fire actions for Muir Woods FMU include a mix of prescribed fire, mechanical fuel reduction, and under-story thinning projects. Prescribed burning has been used to reduce fuel loading as well as to restore the role that fire plays in the ecosystem. Burns would range in size from 0.55 to 50 acres, with 50 acres total as a target for annual burning. Research burns would be conducted to investigate how fire affects SOD.

Adverse impacts on mammals from fire management actions would largely be associated with vegetation change and disturbance. Most mammals are capable of escaping immediate injury or death from fire management actions because of their mobility. Ten species of bats have been documented in Muir Woods National Monument, including four federal species of concern: Townsend's western big-eared bat (*Corynorhinus townsendii townsendii*), fringed myotis (*Myotis thysanodes*), long-legged myotis (*M. volans*), and Yuma myotis (*M. yumanensis*). Many of the bats in Muir Woods National Monument have been detected using redwood fire-scar cavities for roosting, particularly in the riparian corridor. Prescribed fire could destroy maternity roosts, which would be a substantial adverse impact on bats

because of their low reproductive rates. However, fire could also be used as a tool to create new fire scars for bats and other wildlife. The adverse impacts of fire management actions in most cases would be minor and short-term due to the limited areas that are being affected. Long-term beneficial impacts would result from fire actions that restore and enhance native plant communities.

At least 69 species of birds are known to occur within Muir Woods National Monument. The main effects of fire management actions on birds would be changes in habitat and disturbance occurring during the nesting season, March 1 through July 31. Impacts from prescribed fire and mechanical removals would be short-term and minor as these actions would be conducted outside the nesting season, with vegetation regrowth beginning within months. Long-term beneficial impacts would result from fire actions that restore and enhance native plant communities. The consequences of fire management actions on snag numbers and their locations would result in variable impacts on cavity-nesting birds and other species of birds that feed on wood-boring insects (USDA 2000). Conducting snag surveys prior to fire management actions would allow for better planning to protect these resources and determination of whether snags should be created as part of a particular project.

For fish, the primary concerns relative to fire are increases in water temperature and sediment, and the long-term loss of woody debris from stream channels. The most long-lasting and severe effects on fish habitat from fire occur when fire is associated with the loss of streamside forest (McMahon and deCalesta 1990). Loss of riparian vegetation can lead to elevated water temperatures, reducing the ability of the water to hold dissolved oxygen. However, adequate stream buffers would be left along creek areas to ensure that impacts are mitigated to an acceptable level.

Fire management actions would have mixed impacts on invertebrates in Muir Woods FMU. While most invertebrates that live in the surface soil layers and invertebrate eggs are likely to be killed by prescribed fire, some ants and flying surface insects may increase in numbers after a fire. In addition, fire may create snags, which attract a variety of wood-boring insects. Along with reptiles, most amphibian populations show little response to mixed severity understory fires, although species favoring open habitats are clearly favored in the first few years after a fire, before understory and shrub vegetation regenerates (USDA 2000). Because fire actions would be limited in size and location within Muir Woods FMU, the overall impact on invertebrates, amphibians, and reptiles would be adverse, minor, and short-term. The impact on amphibians would be minor because effects would be localized and the riparian area around Redwood Creek would be protected.

Fire management actions would have many benefits in Muir Woods National Monument. Reducing the chances for catastrophic fire would prevent the loss of the last contiguous stand of old-growth coast redwood forest in the region, as well as protect portions of the Redwood Creek watershed. Research on fire effects on SOD may lead to ways to control the pathogen and prevent excessive loss of the tan oak understory, which provides cover and acorns for wildlife. Removal of nonnative plants would foster the reestablishment of native plant species.

Treatment of San Francisco County Project Area

The fuel reduction strategy for San Francisco lands focuses upon maintaining defensible spaces around buildings (see discussion above) and removing nonnative trees. Mechanical removal would cover

between 5 and 10 acres a year. Both of these actions would remove vegetation and disturb soil and litter, possibly affecting small mammals, reptiles, amphibians, invertebrates, and terrestrial landbirds. Adverse effects would be long-term and minor.

Public Information and Fire Education Programs

Impacts associated with fire information and education would largely be indirect and beneficial, although highly dependent on the nature of the fire management action. Pre-planned events such as prescribed fires and mechanical treatment provide the opportunity to demonstrate the effectiveness of natural resource management to local communities and the interested public. During unplanned events, such as wildfires, time for effective communication is often more limited. However, public information and education usually do not have a direct effect – positive or negative – on wildlife. In some cases, education can be used to enforce a closure of an area to ensure that wildlife habitat quickly recovers.

Fire Cache

Having the fire cache and management personnel located centrally within GGNRA would allow for faster response time to wildfires, implying less potential for higher-intensity and larger fires, as well as less intensive suppression activities. The use of existing buildings for the fire cache would avoid impacts on wildlife from construction activities. Fire cache relocation would have indirect, beneficial, long-term effects on wildlife.

Fire Effects Monitoring

There would be some trampling and disturbance effects associated with fuel and vegetation sampling, although these should be relatively minor. The timing of monitoring would influence the intensity of these effects. For example, conducting monitoring outside of peak bird nesting and butterfly flight season would lessen the overall impacts. The knowledge gained through fire behavior monitoring would be beneficial to wildlife. Through gaining a better understanding of how fire behaves in different vegetation communities and in different weather and climatic conditions, park fire specialists would be better able to avoid situations that lead to catastrophic fire events that would be devastating to certain wildlife. Overall, impacts would be long-term, beneficial, and minor.

Alternative A

Mechanical Fuel Reduction

Mechanical fuel reduction projects would focus upon the removal of highly flammable eucalyptus, French broom, and native plants to reduce fuel loads and keep fire roads accessible, particularly to protect communities adjacent to the park from wildfires. The most common method of mechanical fuel reduction is the use of chain saws to thin or remove targeted vegetation, which is then either piled to be chipped, removed, or burned at a later date through the use of pile burns. In some instances, the materials would be left in place, potentially creating cover for some amphibians and reptiles and a source of woody debris that would benefit wood-boring insects and insectivorous birds. Other equipment used during mechanical fuel reduction may include weedwackers, mowers, and masticaters. Herbicides would only be applied according to the approval and guidelines of the park's Integrated Pest Management Program and the Washington Office coordinator for herbicide application. If goats or other animals are used as a type of

mechanical treatment, they would be closely monitored and contained by electric fences to control grazing and prevent contamination of sensitive watersheds and wetlands. Under Alternative A, no more than 100 acres per year would be treated mechanically.

Mechanical fuel reduction techniques, such as mowing, brush clearing and tree removal, would have some adverse impacts on wildlife. Local mechanical treatments may affect ground, brush, and tree-dwelling species by direct mortality or injury to individuals and their nests, eggs, and offspring, or by altering cover and food sources. Mitigations to protect breeding migratory birds would also provide protections to a wide range of species that breed during the spring and summer seasons in the park. Short-term adverse impacts on wildlife during hand-thinning, mowing, and chipping operations include human presence and use of chain saws and other tools during operations. These actions may disturb wildlife, although such disturbance would only be during the period that crews were working.

Conversely, mechanical removal of trees and brush to attain target conditions would enhance habitat for native wildlife and reduce the threat of catastrophic fire, especially from human-caused ignitions that occur in developed areas. Brush clearing can also increase foraging opportunities for some herbivores and predators. The opening of dense forest habitats would benefit some aerial foragers such as bats and flycatchers. Perhaps the largest benefit from mechanical removals of nonnative trees and shrubs would be the benefit to native wildlife from restored native plant communities.

Goats could spread disease to park wildlife, potentially having the greatest impact on black-tailed deer, which are the only other native ungulate in the park. Goats may also trample vegetation and compact soil. Finally, goats would forage on both native and nonnative species, potentially removing native host and nectar plants for butterflies. The impacts on the park's wildlife from goats would be short-term, adverse, and minor.

When cut vegetation cannot be burned onsite or removed for logistical, administrative, or ecological reasons, it may be chipped and distributed over the site. When chips are spread deeply enough to affect the growth of native plants, wildlife would be adversely affected. In the case of specific wildlife species of interest to the NPS, chipping could be applied at decreased depths to avoid these impacts. Impacts on wildlife from chipping would therefore be negligible, adverse, and short-term.

Pile Burning

Piling and burning of downed trees and shrubs may have an adverse effect on some wildlife. Some species, such as small rodents, reptiles, and invertebrates, may take up residence in burn piles between the time they are stacked and the time they are burned, which can be several months. Many of these animals are likely to escape fire once the piles are ignited, but some may perish. The pile-burning methodology should prevent overly hot fires that could sterilize soils and could have long-term impacts. In addition, mitigation to light piles so as to allow wildlife an escape route will be applied when pile burning. Pile burning could also be used to create fire scars or tree cavities that would benefit some species such as bats. Impacts from pile burning would be short-term, adverse, and minor.

Prescribed Burning

The primary use of prescribed burning under this alternative would be to reduce hazard fuels in strategic locations, restore fire to the park landscape for the benefit of native species, and aid in the control of nonnative plant species. Under Alternative A, prescribed burns would be conducted in coastal prairies, coastal scrub, oak woodlands, and redwood forest. Prescribed fire could be used to meet the objectives of lowering the fuel hazard in the historic groves of eucalyptus trees if first treated mechanically to maintain a low-burning fire. Prescribed fire would be applied to determine fire effect on nonnative plants and the restoration of native plant communities. Benefits from prescribed fire would include an increased regulation of forest density, the release of nutrients into the soil, the creation of a favorable reproductive environment for fire-adapted species, and the creation of improved habitat for wildlife. Prescribed burning would also allow for fuel modification in large areas away from structures and high-value areas.

As noted above, fire can be used to improve the nutrient content of vegetation and restore habitat for some species of wildlife. It can also reduce the threat of catastrophic unplanned wildfire and the long-term destruction of habitat. Under Alternative A, prescribed fire would have beneficial, long-term, and minor impacts on some wildlife species by providing open or early seral stage habitat in areas of GGNRA most severely altered by fire suppression, and by continuing to reduce the risk of catastrophic fire. Conversely, species that depend on down wood, dense forests, and ground cover, such as salamanders, some small mammals, and ground-nesting birds, would experience localized adverse impacts in the treated areas from displacement – although prescribed fire would also create some new sources for downed dead wood. These adverse effects would be localized, as an abundant supply of down wood and more closed canopy woodlands would remain in the park, providing habitat for the species dependent on those habitats. Control actions at the boundaries of prescribed fires, such as the removal of vegetation to construct fire lines, would have adverse, long-term, and minor impacts on wildlife in those areas.

Prescribed fires would be started when conditions are favorable. Wildfires and the intentional setting of fire by Americans Indians and ranchers tended to occur when vegetation was dry enough to carry a fire, in the late summer and early fall. Prescribed fires outside of this seasonal timeframe would have an adverse effect on species of wildlife that are adapted to a “natural” timing of fires. Also, high levels of fuel loading in some areas of GGNRA may cause prescribed fires to burn at higher than usual intensities, even when fire prescriptions are designed to minimize intensity. Unnatural seasonality, and in some cases intensity, of prescribed fires could result in greater direct lethal impacts for immobile wildlife (USDA 2000), such as invertebrates, amphibians, or small mammals, than under the pre-suppression fire regimes for the park landscape. Because the areas to be burned are small, impacts on species in the park from these effects of prescribed fire would be no more than minor.

Research

Research under this alternative would lead to better management of plant communities through the use of fire as a tool to move toward desired conditions. Enhanced native plant communities would provide better habitat for most native wildlife. Impacts would be long-term, beneficial, and minor.

Cumulative Impacts

Primary among the past actions that have influenced wildlife at GGNRA are alterations in habitat from fire suppression (in areas that were sustained by fire), urban development and loss of habitat continuity, and the establishment and overall dominance of many areas by nonnative plant species that either exclude wildlife or change distributions of wildlife species over the landscape.

Suppression of periodic fires allowed the unnatural buildup of both dead and live fuels. The buildup of fuels generally increased the risk of wildfire. Development of land in the region, extirpation of some species (California grizzly, tule elk), introduction of species competing for limited habitats, and fragmentation of available habitat have also contributed to changes in occurrence and population sizes of some species. For example, coastal sage scrub is present in about 15 percent of its former habitat, primarily because of agricultural, industrial, and residential development, directly affecting mammal and bird species that use this habitat. Grassland habitats supporting rodents and their raptor predator base have been declining through loss of these habitats to agricultural use or urban development. Regional loss of forest stands through logging, catastrophic fire events, and urbanization have led to fragmented, isolated stands suitable for monarch butterfly and winter roosting sites for numerous bat species.

Current and reasonably foreseeable future actions positively affecting wildlife in the park are activities such as the Big Lagoon, Redwood Creek, and mission blue butterfly habitat restoration projects. These projects take into account the natural processes of the site and incorporate nonnative plant removal and reestablishment of native plant communities (through planting and weed removal) into their efforts, with subsequent direct benefits to wildlife species. Potentially adverse impacts could occur with development projects both within the park and adjacent to park boundaries, including the various transportation plans and trails plans. These efforts will involve ground disturbance activities that could add to or exacerbate existing habitat fragmentation problems along road and trial corridors. However, ongoing efforts to identify mitigations for these projects, such as pre-project coordination with nesting seasons, development and implementation of post-project site stabilization plans, and evaluation of fire management efforts through monitoring and research, would reduce the potential for these type of impacts. These projects would have an overall long-term negligible-to-minor beneficial impact on wildlife as a whole.

Conclusion

The flexible fire suppression strategy has the potential for numerous short-term, adverse impacts on wildlife. These adverse impacts are expected to be minor based on the limited number of wildfires that occur annually in the park. Compared with less sensitive suppression actions, however, preventing a catastrophic fire in the park probably offers greater long-term benefit to the park's wildlife. Having the flexibility to burn in portions of the park to enhance natural resources would benefit wildlife through long-term enhancement of habitat. The fire management strategy for Muir Woods National Monument would provide long-term benefits to wildlife, mainly by restoring fire to the ecosystem, which would outweigh some of the adverse impacts of mechanical removals and prescribed fire. The impacts of in-park and community projects funded by the federal Wildland-Urban Interface Initiative would be beneficial, long-term, and minor. Clearing defensible space around structures and reducing roadway fuel would have long-term, adverse, minor impacts on wildlife. Fuel reductions for San Francisco lands, the public

information and education program, the fire cache relocation, and the fire behavior monitoring program all would have beneficial, long-term, and minor impacts on the park's wildlife.

The effects of mechanical removals on wildlife would be beneficial, long-term, and minor. The benefits of mechanical removals for wildlife – enhancing native habitats and reducing chances for catastrophic fires – outweigh the adverse impacts of vegetation removal and the associated disturbance. Prescribed fire would also have a beneficial long-term minor impact on wildlife by enhancing native habitats and reducing the risk of catastrophic fire. These benefits would outweigh the temporary loss of habitat and possibilities for direct injuries or death associated with prescribed fires. Research under Alternative A also would have a long-term, beneficial, but minor impact. Pile-burning effects would be adverse, short-term, and minor. Only a small portion of the land area of the park would be subject to treatment under Alternative A, and treatment sizes would be small. Overall, the effects of fire management activities on wildlife and important habitat as presented in Alternative A would be long-term, beneficial, and minor.

Impairment

As no long-term, major adverse effects on wildlife would occur, park wildlife resources would not be impaired under Alternative A.

Alternative B

Mechanical Fuel Reduction

Impacts would be similar to those of Alternative A, with a slight increase in the extent of impacts as the amount of land that could be treated under Alternative B would be about twice that of Alternative A. The amount of land treated under Alternative B would remain a small percentage of the total within the park.

Pile Burning

Impacts would be similar to those of Alternative A.

Prescribed Burning

A maximum of 120 acres would be subject to prescribed burning under Alternative B, although fires would not be used in wildland urban interface areas. Impacts would be similar to those of Alternative A.

Research

Impacts would be similar to those of Alternative A.

Cumulative Impacts

Impacts would be the same as under Alternative A.

Conclusion

Overall, impacts on wildlife under Alternative B would be very similar to those under Alternative A. The major change would be more areas subject to mechanical treatments, and some additional restrictions on the use of prescribed fire.

Impairment

No impairment of the park's wildlife would occur under Alternative B.

Alternative C

Mechanical Fuel Reduction

Impacts would be similar to those of Alternative A, though greater in extent with an increase in the amount of land that could be treated under Alternative C. The amount of land subject to treatment under Alternative C on an annual basis would remain a small percentage of the park.

Pile Burning

Impacts would be similar to those of Alternative A, though slightly greater in extent as up to three times as much material would need to be burned under Alternative C.

Prescribed Burning

Impacts on wildlife from prescribed fire would be similar to those of Alternative A, although slightly greater in extent as nearly three times as much area could potentially be burned annually. Burns would still tend to be small in size. The amount of land subject to treatment under Alternative C would remain a small percentage of the park.

Research

Impacts would be similar to those of Alternative A, though greater opportunities for research would exist under Alternative C than under the other two alternatives because there would be more burning occurring.

Cumulative Impacts

Impacts would be the same as under Alternative A.

Conclusion

Overall, impacts on wildlife under Alternative C would be similar to those under Alternatives A and B. However, Alternative C would allow for the greatest and most flexible use of mechanical treatments and prescribed fire to meet fire objectives, including reducing chances of a catastrophic fire and enhancing habitat for wildlife. Alternative C also would allow for more research to occur, providing the most opportunities for park staff to learn adaptively about the use of fire for managing natural resources.

Impairment

No impairment of the park's wildlife would occur under Alternative C.

Impacts on Special Status Species

Analysis

The planning area contains numerous plant and wildlife species that are nationally, regionally, or locally rare. These species span a spectrum of rarity from being federally listed as endangered or threatened under the Endangered Species Act (ESA), to being recognized by the California Native Plant Society (CNPS) or local area species experts as uncommon or rare. For purposes of this document, all of these

species are collectively referred to as "special status species." These species all require consideration when management actions are taken to ensure that actions do not harm the species or their habitats.

Fire management activities have potential to affect many of these species. For example, stream or riparian species could be adversely affected by increased sedimentation in creeks and/or persistent turbidity following wildland or prescribed fire. Fire management activities such as cutting fire line or removing vegetation to reduce fuel accumulations could destroy or harm individuals or damage their habitat. Conversely, as is the case for common plants and wildlife, many special status species in the planning area are adapted to periodic fire, and application of fire to the ecosystems could benefit these species by providing a wider diversity of habitats, by stimulating seed germination, or by improving habitat for prey species.

The U.S. Fish and Wildlife Service and NOAA Fisheries sent lists of federally listed threatened and endangered animal and plant species that may occur in the planning area dated July 2, 2003 and February 27, 2003, respectively. Appendix F and Chapter 3, Affected Environment, of this document list the species that may occur as well as whether or not they are likely to be adversely affected by fire management plan activities, based on the best professional judgment of GGNRA natural resource staff.

The following sections discuss probable impacts on species listed as threatened or endangered by the federal government that may occur from implementing actions in the FMP alternatives. All plant or animal species on this list and present in the planning area were considered in the analysis. Refer to Chapter 3 for a description of the species included in this analysis, and to Appendix F for the complete list of species considered for analysis.

Special Status Plant Species

Federally Listed Species

Raven's manzanita, Marin dwarf-flax and San Francisco lessingia would be affected by unplanned ignitions and associated suppression activities, mechanical fuel reduction actions, or small research burns at the Presidio in San Francisco. The limited extent of these species within the FMP planning area and their location within the summer fog zone and within low-growing serpentine coastal scrub and rock outcrops where fuel loads are minimal to absent make unplanned fire-related impacts on these species unlikely. The species and their locations are monitored on an annual basis, and this information would be used to help mitigate any impacts on individuals or populations in the event of a wildfire.

Other Species Considered in this Analysis

Coast rock cress, Oakland star-tulip, Franciscan thistle, San Francisco wallflower, San Francisco gumplant, arcuate bush-mallow, and Choris's popcornflower could be affected by fire management actions within coastal scrub and grassland communities. Marin manzanita, Glory brush, and Mason's ceanothus could all be affected by actions within the limited chaparral community of the Marin County portion of the Park Interior FMU.

California bottlebrush grass could be affected by actions within native hardwood forests, Douglas-fir and coast redwood forests, and nonnative evergreen.

The large number of coastal dune, salt marsh, and coastal bluff species described in Chapter 3 would only be affected by wildland fires or mechanical treatments at the Presidio in San Francisco. The limited actions planned for the San Francisco lands, and the typical habitat of these species in coastal dunes and sandy areas within the summer fog zone where fuel loads are minimal to absent make unplanned fire-related impacts on these species unlikely, and they will not be discussed further in this analysis.

Actions Common to All Alternatives

Wildland-Urban Interface Initiative. The emphasis of the Wildland-Urban Interface Initiative at GGNRA is to reduce the density of hazardous fuels that create a risk to lives or property on and immediately adjacent to the park boundary. Most projects would continue to focus upon the mechanical removal of nonnative and highly flammable eucalyptus and acacia trees and nonnative shrubs (cotoneaster, brooms) from areas where parklands adjoin neighboring properties. The removal of these nonnative species would have two primary long-term benefits: reducing the chances for large, high-intensity burns, and promoting or allowing for the reestablishment of more compatible native vegetation close to developments. Mechanical removal activities would remove vegetation, disturb soil and forest litter, and change shade and moisture characteristics through loss of overstory cover. With mitigations, including development and implementation of revegetation and weed efforts in conjunction with Wildland-Urban Interface Initiative projects, these short-term adverse impacts would result in minor long-term beneficial impacts on vegetation.

A number of special status plant species, including the coast rock cress, Franciscan thistle, California bottlebrush grass, and San Francisco wallflower, could be affected by these actions. Specific Wildland-Urban Interface Initiative projects would take into account the known and potential populations of these and any other special status plant species, and efforts would be made (through avoidance, or timing or actions) to minimize direct adverse impacts. The purposes of the Wildland-Urban Interface Initiative to remove nonnative plant species and reestablish compatible native vegetation would have long-term minor-to-moderate beneficial effects on the special status plant species that currently occur, and could become reestablished, within these sites.

Defensible Space/Vegetation Clearing Around Structures. The creation of defensible spaces around structures would remove vegetation and disturb soil and litter, with the possibility of increasing cover of nonnative plant species following soil disturbance. However, these species could easily be removed due to their proximity to frequently used areas of the park, and new invasions would be detected early enough to avoid spread into adjacent wildlands. Special status plants and populations within the vicinity of structures would be avoided, and the removal of newly established nonnative plant species in cleared areas would prevent adverse impacts on adjacent populations. Impacts would be negligible with these mitigations, but adverse and long-term because treatments would need to be repeated.

Roadside Fuel Reduction. Fire road maintenance would remove vegetation adjacent to road edges, creating open and available habitat for the invasion of nonnative plant species. Annual special status plant species surveys along roadsides, as well as surveys to detect and stop the spread of new nonnative plant species, can help minimize the potential impacts of these annual actions. Impacts on special status plant

species would be long-term, adverse, and negligible to minor, depending on the extent of populations affected by the activity and the integrity of the surrounding vegetation.

Suppression. The direct effects of unplanned wildland fires on special status plant species could be substantial, and could include long-term, possibly permanent changes in plant species composition or percent cover and the introduction or spread of nonnative plant species. Adverse effects on species can result from fire suppression activities such as construction and use of staging areas, helispots, or spike camps; construction of firelines; and mop-up. As with vegetation overall, individual special status plants and the plant communities that they inhabit can be injured or killed when vehicles are traveling to sites or staging areas or when bulldozers are constructing line, creating avenues for nonnative plant establishment through soil disturbance, loss of native vegetation cover, and changes in light and moisture conditions. It is anticipated that in most cases these impacts would occur infrequently.

Similar effects could result from removal or trampling of vegetation in temporary staging areas and helispots used for suppression activities. Spills of fuel, oil, hydraulic fluid, antifreeze, and other toxic chemicals at staging areas and helispots could directly affect special status plant species though changes in soil chemistry, hydrophobicity, and water uptake properties. All landing areas would meet the standards outlined in the Interagency Helicopter Operations Guide, and safe landing spots identified in the GGNRA Aviation Management Plan Mitigations would be used. These mitigations, in addition to limiting helispot construction and locating helispots away from known special status plant species populations, would reduce these impacts.

Use of water or retardant drops during suppression activities can have both a direct adverse impact – from the sheer force of the physical impact – and a longer-term chemical impact due to the chemical composition of the materials used. Retardants can cause short-term impacts on the overall health and reproductive ability of some species, although long-term effects are not detectable.

The proximity of saltwater to most areas of GGNRA means there is a high likelihood for the use of saltwater or brackish bay water during suppression actions. Short-term die-back in annual or perennial species can result if salts are concentrated in drainages and swales, affecting such species as Franciscan thistle and Choris's popcornflower. Again, these impacts are generally short-term and undetectable over the long-term. The overall long-term impact would be negligible, and the direct impact (force of water/retardant falls) on plants would be minor to negligible. The advantage of water and retardant drops is that in some circumstances they can take the place of hand lines ("wet-lining") to control fire movement. This tactic results in less physical impact on soils, forest litter, and vegetation than hand line construction.

Personnel at fire camps or on suppression crews have the potential to transport weed seeds with their equipment and tools. They would also cause trampling and loss of vegetation cover, which could have short- to long-term adverse impacts. However, locating spike camps away from specials status plant species populations and habitats, such as riparian/wetland swales or chaparral areas, and keeping tools and equipment as clean as possible would help minimize these impacts.

Hand line construction would remove vegetation and disturb soil and forest litter, leading to soil erosion and loss of native seedbanks and soil structure. In all cases, minimum impact suppression tactics (MIST) would be used to minimize ground disturbance; MIST would include use of wet lines and construction of minimal hand lines such as through the use of mowers to break up fuel continuity and retain vegetation stems on the ground surface. Mop-up, or the churning of soil and forest litter to extinguish residual hot spots along the periphery of a fire, would cause additional impacts on soil integrity and the soil seedbank, increasing the potential for introduction and establishment of nonnative plant species within native plant stands. These mechanical actions could also stimulate sprouting of both native and nonnative species in the chaparral communities, which could serve to "flush" weedy species. If continued actions were taken to remove sprouted nonnative species after ground-disturbing activities, there would be a gradual change in species composition with possible beneficial effects on the special status species occurring in these sites.

The use of a flexible suppression strategy and application of the mitigation measures to protect sensitive plant species wherever possible would help mitigate potential adverse impacts. Use of indirect fire lines to take advantage of either natural firebreaks (rock outcrops, bodies of water) or roads or otherwise devegetated areas would have a beneficial effect on natural vegetation areas by minimizing ground disturbance through the construction of direct fire lines with hand tools and machinery. This flexible strategy would allow fire personnel to direct wildland fires toward areas of lower fuel loads, such as previously thinned or cleared wildland urban interface sites, such that the ultimate suppression fire lines would be smaller and less intrusive on the landscape. The level of impact on special status vegetation associated with suppression would be a short-term, minor, adverse impact, with long-term effects.

Treatment of Muir Woods FMU. Fire actions for Muir Woods FMU would include a mix of prescribed fire, mechanical fuel reduction, and understory thinning projects under all alternatives. Of the special status species considered in this analysis, Coast rock cress, Oakland star-tulip, and California bottlebrush grass would potentially be affected by these fire management actions.

Coast rock cress occurs on rocky outcrops within the coastal scrub and grassland communities of Muir Woods FMU where fire is unlikely to carry, although radiant heat from adjacent burns could affect the species. These populations could also be subject to direct impacts associated with implementation of fire actions, such as holding lines or staging areas, but would be avoided through integration of known populations during the project planning process. Impacts on this species in the Muir Woods FMU are likely to be negligible to somewhat beneficial (minor) and long-term where encroaching scrub species are mechanically removed through fire management actions, opening habitat for these plants.

Oakland star-tulip was recently discovered within Muir Woods National Monument and is limited to the grassland areas of the site. The primary threats that if faces are from nonnative plant encroachment. The actions called for in the Muir Woods FMU – prescribed burning and research burns to control nonnative species and reestablish native species composition and structure – could benefit this species. Adherence to specific mitigation measures, such as minimizing ground disturbance activities during implementation of fire actions in grasslands, using carefully designed prescriptions and adhering to those prescriptions, and developing and evaluating specific project objectives, would result in minor-to-major beneficial effects on

this species, depending on the condition of the site prior to the action. For example, a prescribed burn, timed during the dormant phase of the bulb's life cycle and implemented in an area with a dominant nonnative grass cover, could be converted to native grassland supporting Oakland star-tulip. This would have a major beneficial effect on this species.

The proposed fire actions in the forest and woodland areas of Muir Woods FMU would potentially affect California bottlebrush grass, which inhabits understory areas of Douglas-fir and native hardwood forests. Stands and populations of this species appear to be stable, and actions associated with mechanical thinning, pile burning, and prescribed burning could temporarily affect these populations. Long-term alterations in overstory cover, such as through management of Douglas-fir stands within coastal scrub areas, could adversely affect populations found in those areas. However, this native perennial bunchgrass may respond favorably to fuel reductions and thinning, which would clear out new areas of habitat in some areas of the FMU. The adverse impacts of fire management actions in most cases would be minor and short-term due to the limited areas that would be affected, and negligible with inclusion of all mitigation measures. Long-term beneficial impacts would result from fire actions that restore and enhance native plant communities and vegetation structure.

The fire management actions proposed in the FMP would have many long-term benefits in Muir Woods National Monument, including reducing the chances for catastrophic fire in this last contiguous stand of old-growth coast redwood forest in the region. The associated benefits of restoring natural fuel loads and native species composition within the varied vegetation communities would have long-term moderate beneficial impacts on these special status plant species.

Treatment of San Francisco County Project Area. Fuel reduction strategies for San Francisco lands focus on maintaining defensible spaces around buildings (see discussion above) and removing nonnative trees. Mechanical removal would cover between 5 and 10 acres a year, and would be coordinated with specific objectives identified in the Presidio Vegetation Management Plan/Environmental Assessment. The special status plant species that could potentially be affected by these actions are the three federally listed species (Raven's manzanita, Marin dwarf-flax, and San Francisco lessingia), as well as coast rock cress, Franciscan thistle, San Francisco wallflower, and San Francisco gumplant.

All of these species are located within low-growing serpentine coastal scrub, grassland, and rock outcrops where fuel loads are minimal to absent. All occur, however, within the vicinity of nonnative trees that could be considered for removal. Nonnative tree removal could have both direct adverse impacts on individual plants during fuel reduction actions and long-term beneficial impacts through restoration of available habitat for these species. Trees in these areas capture moisture from fog, shade normally sunny or exposed sites, and change soil chemistry through the addition of tannins and oils from leaf and bark litter. Removal of trees, with follow-up site management to control other nonnative species, could restore the physical attributes of these coastal sites to conditions more favorable for each of the special status plant species.

The limited population extent of each special status plant species within the GGNRA-managed lands of San Francisco, along with annual mapping and monitoring of each population within the FMP planning area, enable fire managers to avoid these populations during fire management actions. These projects

would require careful planning and consideration of all potential changes in habitat conditions prior to any trees being removed from the vicinity of a special status plant species site. Further consultation with the USFWS would be required before conducting small research burns specified in the objectives of approved recovery plans for these species. This consultation would evaluate the potential for habitat enhancement through burning, which could have a beneficial effect. The potential associated impacts related to tree removal in the vicinity of Raven's manzanita, Marin dwarf-flax, and San Francisco lessingia would also require further consultation. While unlikely, these direct impacts could be extremely damaging and must be avoided

Overall, the fuel reduction actions for San Francisco lands, in association with careful planning and implementation of these projects when in the vicinity of special status plant species, would have a long-term minor beneficial impact on these species due to the elimination of competing plants and their increased fuel load, resulting in a reduction of risk of unplanned fire effects, as well as removal of nonnative trees and their effects.

Public Information and Fire Education Programs. No impact on any plant special status species is expected from the distribution of fire information or education.

Fire Cache. Centrally locating the fire cache and management personnel within GGNRA would allow for faster response time to wildfires, implying less potential for higher-intensity and larger fires and smaller associated impacts from suppression activities. The use of existing buildings for the fire cache would avoid impacts on special status plant species from construction activities. Fire cache relocation would have indirect, minor beneficial impacts on all special status plant species within the planning area.

Fire Effects Monitoring. There would be some direct trampling and disturbance effects associated with onsite monitoring of vegetation and fuels, although these would be relatively minor and the timing of monitoring would influence the intensity of these effects. For example, conducting fieldwork during early spring growth when herbaceous species are easily crushed and soils are wet and erodible would have a very localized minor adverse effect. The knowledge gained, however, through monitoring and subsequent data analysis would be beneficial to vegetation overall, and to special status plant species through a better understanding of how fire behaves and affects different vegetation communities. Overall, the impacts associated with monitoring fire effects would be minor to moderate, long-term, and beneficial.

Alternative A

Mechanical Fuel Reduction. Mechanical treatment would continue in the nonnative forests in Marin, San Francisco, and San Mateo counties; the coast redwood and Douglas-fir stands at Muir Woods National Monument; and the grassland and coastal scrub, and chaparral communities in all three counties, with an emphasis on Marin County. The focus of mechanical treatments – removal of eucalyptus, Monterey pine and cypress, acacia, and other flammable trees along the urban interface, with some removal of Scotch and French broom and other nonnative shrubs – would be to reduce fire hazards and limit nonnative species spread through reduction of mature plants. Some work would take place to reduce fire hazards and facilitate implementation of prescribed burns in the Douglas-fir and coast redwood forests of Muir Woods. Soil disturbance would occur during this work due to the use of chipping and hauling equipment, with associated potential for nonnative plant species establishment or spread.

The impacts on special status plant species would be mostly beneficial. Potentially direct short-term adverse impacts on individual plants or populations from mechanical damage through trampling, dragging, and use of heavy equipment would be avoided by incorporating known locations and habitats of each species into the project planning process, and timing work to avoid affecting species in critical phenological periods (flowering, setting seed) within the project area.

Removal of nonnative shrubs in the coastal scrub and grassland and areas of Marin and San Mateo counties would potentially have long-term minor to moderate beneficial impacts on San Francisco wallflower, arcuate bush-mallow, and Choris's popcornflower at Sweeney Ridge, and Oakland star-tulip, coast rock cress, and Franciscan thistle in Marin County through restoration of available habitat, removal of overshading and competing shrubby vegetation, and removal of fuels that could lead to wildland fires with associated suppression impacts that could harm these species. Within the limited chaparral areas of the park, removal of nonnative shrubs and fire road clearing could have direct adverse impacts on Marin manzanita, Glory brush, and Mason's ceanothus, since these species are difficult to distinguish, except when in flower, from the more dominant and widespread chaparral plants. Project planning in this area would include surveys to detect these rare species within proposed thinning areas, and individual plants should be tagged and avoided to prevent inadvertent cutting and removal, such that impacts would be, at worst, adverse and minor to negligible.

California bottlebrush grass would benefit from the same effects within the Douglas-fir and native hardwood forests of Marin, with potentially short-term minor adverse impacts resulting from direct damage to plants, and longer-term beneficial impacts from restoration of understory structure within these stands. Continued efforts to remove nonnative trees along the wildland urban boundary with follow-up reestablishment of native vegetation communities including coastal scrub and grasslands could increase the available habitat for some of these plant species.

The overall effects of mechanical fuel reduction on special status plant species under this alternative would be minor to moderate, long-term, and beneficial.

Pile Burning. Piles of cut vegetation could be burned following mechanical treatments. To prevent impacts from the concentrated heat effects that occur when piles are burned, the piles would be constructed away from sensitive resources, including special status plant species populations. Piles would be limited in size, and would be burned during seasons when the potential for adverse impacts on adjacent native vegetation would be minimal. Pile burns under this alternative would focus only on those plant communities mentioned above in association with mechanical treatments: coastal scrub and chaparral, grasslands, Douglas-fir and coast redwood, and nonnative evergreen forests. The effects on special status plant species, with mitigations (timing, placement, avoidance of known populations), would be the same as those described for mechanical fuel reduction.

Prescribed Burning. The plant communities that could be treated with prescribed fire under this alternative are the grassland and coastal scrub, broadleaf evergreen forest, old-growth redwood forest, second-growth redwood and Douglas-fir, and nonnative forests. Chaparral would not be treated with prescribed fire under this alternative. The primary focus of treatment would be to manage hazardous fuels in strategic locations such as along the wildland urban interface, to mimic the effects of natural fires, and

to aid in controlling nonnative plant species including Scotch broom, French broom, eucalyptus, and cotoneaster.

As with mechanical fuel reduction, the effects of prescribed burns on special status plant species would be variable depending on timing, mitigations, and the species involved. Short-term adverse impacts could occur from direct burning of individual plants, damage associated with soil disturbance from construction of holding lines for burn implementation or mop-up after the burn, and immediate postburn sprouting of nonnative seedlings. However, post-fire (manual) management of these nonnative species, along with direct removal of nonnative competitors and in conjunction with the beneficial role fire plays in maintaining open areas and clearing out unnaturally dense, stimulating reproduction of native species, would ameliorate these effects. Even though individuals of some special status species could be killed by prescribed fire, the removal of competitors has a long-term beneficial effect, as fire-adapted native species return while the competitors often do not (U.S. Geological Survey, National Biological Service 1995).

Lack of prescribed burning within the chaparral areas of the park and within the habitat for three of the park's chaparral-specific locally rare species – Marin manzanita, Glory brush, and Mason's ceanothus – would have long-term minor-to-moderate adverse impacts on these plants and populations. These three species are all fire-adapted, and may be dependent on the heating, seed scarification, and epicormic sprouting that fires create. In particular, glory brush, a small-statured shrub prone to overcrowding and shading by more common ceanothus and manzanita shrubs, could be completely crowded out in a short number of years. Sole reliance on mechanical means to manage this vegetation type would result in a continued decline in the overall health and abundance of these species, despite the continued survival of chaparral structure through both unintentional fires and mechanical thinning.

Although prescribed fires under this alternative would result in direct, long-term benefits on the special status species within burnable areas, the prescribed fires would be limited in scope, would not involve a large component of the total population of each special status species, and would exclude the chaparral-dependent species. As a result, the overall effects would be negligible to minor and beneficial for special status plant species.

Research. Research burns on Harding grass and Scotch and French broom would continue, helping ecologists refine burning prescription parameters to control these species. The research burns could have substantial benefits to the natural coastal scrub and grassland communities both within the park and in the region, with potentially beneficial effects through greater knowledge of fire effects on San Francisco wallflower, arcuate bush-mallow, and Choris's popcornflower at Sweeney Ridge, and Oakland star-tulip, coast rock cress, and Franciscan thistle in Marin County. Alternative A allows for additional research or test plots in each of the six FMUs, although specific research questions have not been formulated for these areas. Research into the effects of fire on SOD would potentially reduce SOD's impacts on the native hardwood Douglas-fir and coast redwood forests of the park, with beneficial effects on California bottlebrush grass. Research burns could also be conducted in San Francisco for federally listed plant species, in concurrence with recovery plan objectives. The overall impacts of research on special status plant species under Alternative A would be long-term, beneficial, and negligible to minor.

Cumulative Impacts. Primary among the past actions that have influenced special status plant species at GGNRA are urban development and loss of habitat continuity, the establishment and overall dominance by nonnative plant species, and fire suppression (in areas that were sustained by fire). Suppression of periodic fires has favored fire-intolerant and nonnative plant species, and allowed the unnatural buildup of both dead and live fuels. Shrub and grassland habitats are experiencing encroachment by fire-intolerant conifers and nonnative trees, with associated impacts on locally rare plant populations with specific habitat requirements. Urban development and landscaping have also reduced the available habitat for these species, with the gradual creation of "islands" of intact vegetation surrounded by infrastructure and associated nonnative species. Populations of rare plants have become isolated from each other, with minimal opportunity for cross-pollination or seed movement. This gradually causes a reduction in the overall adaptability or elasticity of populations to respond to changing environmental conditions, resulting in long-term adverse impacts on population sizes and overall species survival.

Current transportation, trail, and development planning efforts within the park and beyond NPS-managed boundaries would have direct short-term effects on special status plant species within the disturbance area, and long-term direct and indirect effects on vegetation as a whole through potential creation of habitat (through ground disturbance activities) for nonnative plant species encroachment and establishment. However, ongoing efforts to identify mitigations for these projects, such as pre-project weed control, post-project planting and weeding, and use of weed-free products (soils, fill material, and clean equipment), would reduce the potential for these type of impacts. Since special status plants are mapped and monitored on a regular basis, and are considered during site design and avoided wherever possible, these impacts would be minor to negligible. Other ongoing programs, including nonnative plant removal projects within the park, Wildland-Urban Interface Initiative projects on private lands and lands managed by other agencies adjacent to GGNRA-managed lands, and implementation of the Point Reyes National Seashore Fire Management Plan and the Vegetation Management Plan for the Presidio, would beneficially affect the park's vegetation and associated rare plant species.

Conclusion. Limited prescribed burning and mechanical fuel treatments would have minor-to-moderate beneficial long-term impacts on the special status plant species growing within the coastal scrub, grassland, and forested areas of the park. Removal of individual nonnative trees would have a localized minor-to-moderate long-term beneficial impact on the federally listed Raven's manzanita and Marin dwarf-flax, as well as other locally rare species in the Presidio. These beneficial impacts would only occur and persist if mitigation measures for species-specific protection were followed and continued efforts were put forward to remove new nonnative plant recruits after treatments. Average unplanned wildfires and their suppression could have minor, short-term adverse or beneficial impacts on special status plant species. Benefits may result from stimulation of fire-adapted native species, or from the destruction of nonnative plants. Adverse impacts may come from the loss of native species, as well as from crushing, removal, or other physical impacts of suppression actions. Mechanical fuel reduction in Douglas-fir and hardwood forests would result in negligible-to-minor short-term adverse impacts on California bottlebrush grass. The continuation of research and wide application of its results would increase these benefits over a wider geographic area. Reliance on mechanical treatments to manage chaparral areas would have adverse impacts on the rare plants within this community.

Overall, the cumulative effects of past, present, and reasonably foreseeable future actions in conjunction with actions called for in this alternative would have long-term negligible-to-minor and beneficial effects on special status plant species, due in large part to the lack of current fire management actions in many areas of the park, extent of nonnative plant species dominance, and lack of actions focused on nonurban interface areas.

Impairment. No impairment of special status plant species would result from this alternative.

Alternative B

Mechanical Fuel Reduction. Under this alternative, up to 230 acres of vegetation would be mechanically treated. Work would focus on the WUI FMU in Marin, San Francisco, and San Mateo counties (170 acres), the Muir Woods FMU in Marin County (5 acres), and the Park Interior FMU (55 acres). Although the total acreage of mechanical fuel reduction projects per year would be greater than under Alternative A, the direct impacts on special status plant species would be reduced due to the limited nature of actions, with a reduced focus on restoring and sustaining native habitat in the park interior portions of the park in Marin and San Mateo counties. Thus, with the implementation of the mitigation measures described for Alternative A, the impacts on special status plant species under Alternative B would be negligible to minor, long-term, and beneficial.

Pile Burning. The overall effects of pile burning on special status plant species, with mitigations (timing, placement, avoidance of known populations), would be the same as described for Alternative A, but beneficial impacts would be reduced because the scope of Alternative B would be limited to the WUI FMU and developed areas of the park. Impacts would be negligible to minor, long-term, and beneficial.

Prescribed Burning. The areas that could be treated with prescribed fire under Alternative B are limited to the Park Interior and Muir Woods FMUs in Marin County. The Muir Woods FMU treatments and impacts are described above in the “Actions Common to All Alternatives” section. For the Park Interior FMU, acreage that could be treated with prescribed burning under Alternative B would be slightly higher than under Alternative A, with potential actions in the coastal scrub and chaparral, grasslands, native hardwood forest, Douglas-fir and coast redwood, and nonnative evergreen forest communities. As noted above, the primary focus of prescribed burn treatments would be to manage hazardous fuels in strategic locations such as along the interface with the WUI FMU, and adjacent to developments within the park interior areas.

The species-specific effects of prescribed burning in Alternative B would be the same as those described for Alternative A. The primary differences would be the elimination of the opportunity to conduct prescribed burns in San Mateo County, and the addition of conducting burns within the chaparral community of Marin County. Burning in chaparral would have minor, short- and long-term benefits to the chaparral-specific locally rare species – Marin manzanita, Glory brush, and Mason’s ceanothus. These three species are all fire-adapted, and may be dependent on the heating, seed scarification, and epicormic sprouting that fires create. However, limiting management of San Mateo County lands to solely mechanical means could result in the eventual loss of arcuate bush-mallow and other species dependent on open, unshaded rocky outcrops and grasslands. Although prescribed fires under this alternative would result in direct, long-term benefits to the special status species within burnable areas, they would continue

(as with Alternative A) to exclude a large component of the total population of each special status species, and would be limited in scope much as with Alternative A. Despite the benefits within the areas that could be burned, the overall impacts on special status plant species would be the same as described for Alternative A – negligible to minor and beneficial.

Research. Alternative B only allows for burning within Marin County in the Park Interior and Muir Woods FMUs, and in San Francisco for research purposes specific to the federally listed species. This limits applicable research questions that would inform management and protection of all of the park's special status plant species. The overall impacts of research on these species under Alternative B would be beneficial, long-term, and negligible to minor.

Cumulative Impacts. Cumulative impacts would be the same as described for Alternative A.

Conclusion. Overall impacts would be the same as described for Alternative A – long-term, negligible to minor, and beneficial – although burning and its associated benefits could occur within the chaparral areas of the park. Alternative B's confined focus on the urban interface and developed areas of the park and on hazard fuel reduction, and lack of fire as an option within San Mateo County and the WUI FMU, would limit the beneficial effects of fire management actions on special status plant species throughout the park.

Impairment. No impairment of special status plant species would result from this alternative.

Alternative C

Mechanical Fuel Reduction. Despite the increase in acreage of mechanical fuel reduction called for in Alternative C and application of the mitigation measures described for Alternative A, the overall effect on special status plant species under Alternative C would continue to be minor to moderate, long-term, and beneficial (same as Alternative A).

Pile Burning. Piles of cut vegetation could be burned following mechanical treatments, and the overall strategy, implementation, mitigations, and effects would be the same as described for Alternative A. In association with increased mechanical treatments, pile burns under Alternative C would increase substantially over the number called for in Alternatives A or B. Pile burning, with applicable mitigations, would result in short-term direct impacts on the underlying soils, with negligible effects on special status plant species, which would be specifically avoided. Long-term impacts would be minor to moderate and beneficial, in that this work could be conducted throughout the park with overall improvement of vegetation and rare plant habitat through the removal of nonnative species and restoration of vegetation continuity.

Prescribed Burning. The areas that could be treated with prescribed fire under Alternative C would include all areas and FMUs of the park , and the number of potential acres that could be treated annually would increase substantially over the other alternatives. (The Muir Woods FMU treatments and impacts, and the San Francisco research burns, are described above in the "Actions Common to All Alternatives" section.) The opportunity for conducting small-scale research burns and studies within the WUI FMU, in conjunction with larger broadcast burns in the Park Interior FMU, would help create a more seamless blend of management strategies across the park rather than along management zone boundaries. Potential

prescribed burn actions would occur in all vegetation types, and could be used to study and manage special status plant species within these areas of the park. The overall impacts would be minor to moderate, beneficial, and long-term.

Research. As with Alternatives A and B, research burns on a variety of nonnative species would continue, helping ecologists refine burning prescription parameters that could help control these species. Research on the effects of fire treatments on the SOD pathogen could also be conducted throughout the park, with possible reductions in SOD's impacts on the native hardwood, Douglas-fir, and coast redwood forests of the park. Research opportunities under this alternative would include the WUI FMU, with the potential for investigation, for example, into the effects of buildup (and control of) native soil pathogens on special status species that occur within this management unit. Research burns could also be conducted in San Francisco for federally listed plant species, in concurrence with recovery plan objectives. The overall impacts of research on special status plant species under Alternative C would be long-term, beneficial, and minor.

Cumulative Impacts. Cumulative impacts would be the same as described for Alternative A.

Conclusion. Unplanned wildfires and associated suppression activities would continue to have minor, short-term adverse or beneficial impacts on special status plant species, depending on the location of the fire, the timing of the event, and the immediate and long-term impact mitigation measures applied to the site. The substantially increased potential for mechanical fuel treatments (and associated pile burning) that would occur with Alternative C (as compared to Alternatives A or B) would have minor-to-moderate, long-term and beneficial impacts on special status plant species. These beneficial effects would be applied to all areas of the park, rather than focusing simply on the developed and wildland urban interface areas of the park.

The prescribed burn actions proposed under Alternative C, in conjunction with mechanical and pile burn treatments, would have minor-to-moderate, beneficial, and long-term impacts. There would be a greater potential for creation and maintenance of continuous ecologically sustainable stands of native vegetation through the increased opportunity to use a broader range of management tools. Continued studies and research, along with adjustment of burn prescriptions, would result in minor beneficial long-term impacts throughout the park.

Overall, the cumulative effects of past, present, and reasonably foreseeable future actions in conjunction with actions called for under Alternative C would have long-term, moderate, beneficial effects on special status plant species.

Impairment. No impairment of special status plant species would result from this alternative.

Special Status Wildlife Species

Wildlife Species Included in Analysis

The following federally listed wildlife species are included in this analysis.

San Bruno Elfin Butterfly (*Callophrys mossii bayensis*) – Endangered. Fire management actions may have considerable lethal effects on San Bruno elfin butterflies in localized areas in San Mateo County, particularly during the egg and larval stages of their life cycles. Eggs, larvae, and adults would likely be killed during a wildfire or prescribed fire, although the patchy habitat distribution on rocky outcrops may limit the extent of mortality. It is not known whether fire has the potential to enhance habitat for the San Bruno elfin butterfly. It is unlikely that mechanical treatments would occur in San Bruno elfin habitat, but the host plant (*Sedum spathulifolium*) could easily be avoided during treatment.

Mission Blue Butterfly (*Icaricia icaroides missionensis*) – Endangered. Fire management actions may have considerable lethal effects on mission blue butterflies in localized areas, particularly during the egg and larval stages of their life cycles. While most eggs and larvae would be killed during prescribed fire or mechanical removals, the disturbance from these actions may lead to habitat enhancements for the butterfly. These benefits may include increasing the abundance and spatial distribution of *L. albifrons* or other preferred nectar plants, or reducing the incidence of fungal infections on the lupine by killing fungal spores.

Tidewater Goby (*Eucyclogobius newberryi*) – Endangered. Within the planning area, tidewater goby is known only from Rodeo Lagoon in the Marin Headlands. On November 20, 2000, critical habitat for the southern California populations was designated (65 FR 69693), although no critical habitat was designated for northern California.

The USFWS has determined that the principal threats to the tidewater goby include loss and modification of habitat, water diversions, predatory and competitive introduced fish species, habitat channelization, and degraded water quality. Unlike listed salmonids, tidewater gobies are resident fish, and therefore all life history stages could potentially be affected by project activities. Because tidewater gobies are currently only found in Rodeo Lagoon, impacts of fire management activities are restricted to this location.

Coho Salmon, Central California Coast (*Oncorhynchus kisutch*) and Steelhead Trout, Central California Coast (*O. mykiss*) – Threatened. Central California coast coho salmon and Central California steelhead (hereafter referred to as coho and steelhead) occur in several creeks in GGNRA as described in Chapter 3.

To determine the effects of the proposed action on listed salmonid species and designated critical habitat, NPS staff compared habitat potential in absence of the particular actions with the habitat conditions resulting from the proposed actions and mitigation measures. As guidance, staff used essential habitat features for the comparison. The essential features of critical habitat include substrate, water quality, water quantity, water temperature, water velocity, cover/shelter, food, riparian vegetation, space, and safe passage (NOAA Fisheries 1999).

Fire can modify the quantity, quality, and use of salmonid habitat by altering riparian cover, water temperatures, sedimentation rates, nutrient availability, food resources, and woody debris in streams. Because the small- to medium-sized streams that provide habitat for coho salmon and Central California coast steelhead have narrow valley floors, steep hillsides, and abundant rainfall, they are particularly sensitive to the effects that fire can have (e.g., removing vegetation, increasing erosion). Riparian zones

and fish populations can be influenced by fire and fire management activities occurring upslope as well as along the stream, although with applicable mitigations these impacts would be minimized.

Water temperature is a major factor affecting fish survival, distribution, and production, and can lead to alterations in the timing of critical life history events such as emergence of fry from spawning beds and smolt migration, or to changes in fish species composition in streams. These indirect, longer-lasting impacts on water temperature can significantly affect fish populations. Research indicates that streamside vegetation can play an important role in maintaining water temperatures. Evidence shows that when streams are protected from fires by a buffer strip of vegetation, there is no increase in water temperature during burning (McMahon and deCalesta 1990). As noted in Chapter 2, park scientists would review any given burn plan and determine whether riparian vegetation along streams in the area may need to be retained during a prescribed burn. It is likely that this mitigation measure would be added if coho or steelhead are present, preventing more than minor impacts from water temperature changes.

High levels of fuel loading in some areas of the park may create hot spots, or prescribed fires that burn at higher than natural intensities. This would decrease over time as more and more acreage is cumulatively treated, but could cause increased runoff and nutrient loads, even when fire prescriptions are designed to minimize high-intensity fires.

Many studies have assessed the effects of fine sediment on salmonid populations. Direct effects of suspended sediments on fish begin to be observed between 50 and 100 milligrams per liter (Herbert and Merkens 1961, Newcombe and MacDonald 1991, Newcome and Jensen 1996). Chronic exposures to concentrations greater than 100 milligrams per liter impaired feeding and caused reductions in growth rates, avoidance, and downstream displacement. Adult anadromous fish may avoid concentrations greater than 350 milligrams per liter, impeding upstream migrations (Brannon et al. 1981, Whitman et al. 1982). Stress, as measured by changes in blood chemistry, was reported in fish exposed for short periods to sediment concentrations as low as 50 milligrams per liter (McLeay et al. 1983). Despite these indications of adverse effects, salmonids thrive in turbid rivers of the northwest, and are able both to live and reproduce in them, even when sediment concentrations are quite high. For example, steelhead were able to spawn in the North Fork of the Toutle River in August 1980, only three months after the eruption of Mount Saint Helens in Washington.

California Red-Legged Frog (*Rana aurora draytonii*) – Threatened. The planning area supports breeding populations of California red-legged frogs. Past surveys of aquatic and wetland (including riparian) habitats have found red-legged frogs using such habitats in Marin and San Mateo counties. Known breeding populations have been found in the Park Interior and WUI FMUs.

Lands in GGNRA comprise one of the 57 core areas for focused recovery of red-legged frogs established in the Final Recovery Plan for the species (USFWS 2001). Although breeding populations of frogs are present in GGNRA, there are far fewer breeding localities and generally lower abundance than what has been documented in lands managed by PRNS. The significance is that fire management activities could have a more significant impact on the long-term viability of frogs at GGNRA than at PRNS. The planning area has few sites that fall within the definition of proposed critical habitat, which includes essential

aquatic habitat, associated uplands, and dispersal habitat connecting essential aquatic habitat (USFWS 2001).

The types of impacts that fire management activities could have on red-legged frog aquatic habitats are summarized in Table 4-16. These findings are based on the Draft Recovery Plan and proposed critical habitat.

Table 4-16: Potential Impacts on California Red-Legged Frog Habitats from Fire Management Activities

Impact	Habitat Affected and Potential Effect
Emergent vegetation removal	**Breeding/Foraging Habitat** Emergent vegetation is necessary for amplexus and anchoring egg masses. Excessive levels of water may reduce sunlight needed for growth of algae, which is chief larvae food.
Shading vegetation (emergent and bank side) removal	Harmful to adults, mostly, for whom shaded refugia may be critical in drier inland areas during the summer.
Insect habitat vegetation removal	**Foraging Habitat** Harmful to adults and juveniles that mainly feed on invertebrates for which bank side vegetation is prime habitat.
Excess water drawdown in ponds	**Breeding/Foraging Habitat** Leaves egg masses stranded on vegetation. Temporary loss of nonbreeding areas if adults and juveniles are displaced.
Changes to hydrological regime	**Breeding/Foraging Habitat** Pools may dry before metamorphosis is completed. Temporary loss of nonbreeding areas if adults and juveniles are displaced.

Source: NPS, 2004.

A variety of mitigation measures would be used to reduce intensity of adverse impacts to a minor level. All prescribed burn plans and plans for mechanical treatment in a given year would be reviewed and any important riparian areas or other habitat for red-legged frogs would be carefully considered during the planning phase. Under all alternatives, fire management actions would adhere to the mitigation measures outlined in Chapter 2.

San Francisco Garter Snake (*Thamnophis sirtalis tetrataenia*) – Endangered. The San Francisco garter snake is known to occur at Mori Point in San Mateo County, and potentially suitable habitat may be found at other GGNRA localities in San Mateo County. No critical habitat has been designated for the garter snake.

Unlike anadromous fish, the garter snake is a resident species, and all life stages could be potentially affected by project actions. Because San Francisco garter snakes are found only in San Mateo County lands (for the purposes of this project), impacts of fire management activities would be restricted to this location. The recovery plan for the species identifies the alteration and isolation of habitats as the principal reason for the decline of the species (USFWS 1985). These impacts include loss of wetlands and adjacent upland habitat, stream and creek channelization, removal of emergent riparian vegetation, and riprapping of streambanks and shorelines (USFWS 1985). Because California red-legged frogs are an important prey item for this species, effects on red-legged frogs from fire management activities are expected to have cascading effects on the snake.

Marbled Murrelet (*Brachyramphus marmoratus marmoratus*) – Threatened. Marbled murrelets would not be directly affected by fire management activities. However, potential old-growth habitat (in Muir Woods National Monument) may be adversely affected by catastrophic wildfire or beneficially affected by prescribed fire or mechanical treatments that enhance old-growth forest characteristics.

Western Snowy Plover (*Charadrius alexandrinus nivosus*) – Threatened. Snowy plovers, present on Ocean Beach in San Francisco from July through April, could be adversely affected by disturbance from rare fire suppression activity on or near sand dunes at Ocean Beach. Any effects would be minor and of short duration.

California Brown Pelican (*Pelecanus occidentalis californicus*) – Endangered. Large numbers of roosting brown pelicans could be adversely affected by fire management activities, particularly in the Rodeo Beach, Rodeo Lagoon, and Bolinas Lagoon areas during summer and fall, as a result of disturbance from air support and water drafting activities related to fire suppression.

Northern Spotted Owl (*Strix occidentalis caurina*) – Threatened. Northern spotted owls occupy all evergreen forested habitat north of Highway 1 in Marin County. Some forested areas, including Oakwood Valley, have not been adequately surveyed to determine occupancy. Spotted owls in Marin County are known to nest in very small (less than 10 inches diameter at breast height [dbh]) to very large evergreen trees, including California bay, coast live oak, tanbark oak, Douglas-fir, coast redwood, and bishop pine. Spotted owls forage on a variety of small mammals and birds in forested habitat, including riparian areas, as well as in scrub and grassland bordering forested areas. A wide range of fire management activities have the potential to affect spotted owls. Impacts may include habitat alteration from wildfire, prescribed fire, and mechanical treatment; noise associated with suppression activities and mechanical treatment; and potential for widespread habitat destruction from catastrophic wildfire.

Salt Marsh Harvest Mouse (*Reithrodontomys raviventris*) – Endangered. The salt marsh harvest mouse may occur in wetland habitats at Rodeo Lagoon and Bolinas Lagoon and could be affected by wildfire or fire management activities, including prescribed fire; staging; construction of fire lines; use of saltwater, foam, or retardants; and post-fire invasion by nonnative plants.

Actions Common to All Alternatives

Wildland-Urban Interface Initiative. The cooperative Wildland-Urban Interface Initiative would occur under all alternatives and would consist of reducing fuels along the park boundary, inside the park. Most

projects would continue to focus on mechanical fuel removal, understory thinning, and pile burning of flammable trees (primarily nonnative eucalyptus and pines) and brush from areas where lives and property are at risk. The program would affect special status wildlife species as follows.

- **San Bruno Elfin Butterfly.** The removal of nonnative trees could lead to long-term benefits for San Bruno elfin butterflies in some areas by reducing the chances for large, high-intensity burns, and promoting or allowing for the reestablishment of native vegetation communities. Since most of the areas with dense stands of nonnative trees do not currently support San Bruno elfin butterflies, there would no impacts from these actions.

- **Mission Blue Butterfly.** The removal of nonnative trees could lead to long-term benefits for mission blue butterflies in some areas by reducing the chances for large, high-intensity burns, and promoting or allowing for the reestablishment of native vegetation communities. Since most of the areas with dense stands of nonnative trees do not currently support mission blue butterflies, there would not be adverse impacts from these actions, and long-term impacts would be minor and beneficial.

- **Coho Salmon and Steelhead.** Potential adverse impacts may result from Wildland-Urban Interface Initiative activities at locales where listed salmonids and their habitat are present. Mitigation measures, including the requirement for an adequate setback from habitat, would be applied and site-specific correlations developed as needed on a project-by-project basis. Potential impacts would be short-term, minor, and adverse. Long term beneficial effects would occur, however, if removal of nonnative species and native plants were restored.

- **California Red-Legged Frog.** Potential short-term, negligible, adverse impacts may result from Wildland-Urban Interface Initiative activities at locales where red-legged frogs and their habitat are present. Mitigation measures would require pre-approval surveys of all potential habitat areas that could be disturbed and the protection of critical habitat values, with long-term negligible beneficial impacts.

- **San Francisco Garter Snake.** Potential short-term, negligible, adverse impacts may result from Wildland-Urban Interface Initiative activities at locales where San Francisco garter snakes and their habitat are present. Mitigation Measures SS-5, SS-6, and SS-19 would reduce potential for inadvertent take or habitat disturbance, and direct impacts would be short-term and negligible. Long-term, beneficial, minor-to-moderate impacts would occur with habitat restoration.

- **Marbled Murrelet.** Marbled murrelet critical habitat exists on adjacent state park lands in Marin County and on San Francisco watershed and county park lands in San Mateo County. Removal of nonnative trees in forested habitat may have long-term beneficial effects on marbled murrelet habitat by providing long-term enhancement and protection of potential marbled murrelet habitat through reduced risk of catastrophic wildfire in adjacent coast redwood/Douglas-fir forests. Avoidance of impacts on murrelets is addressed by Mitigation Measures SS-20 and SS-21.

- **Northern Spotted Owl.** The removal of eucalyptus and other nonnative trees would have two primary long-term benefits for spotted owls: reducing the chances for large, high-intensity burns, and promoting or allowing for the reestablishment of native vegetation, which may increase the abundance of their preferred prey. Work crews would be a disturbing element for owls in project areas, so Mitigation Measure SS-14 restricts project work during the nesting period. Adverse effects would be short-term and minor. Beneficial impacts would be long-term and minor to moderate.

Defensible Space/Vegetation Clearing Around Structures. These actions would affect special status wildlife species as follows.

- **San Bruno Elfin Butterfly.** Most San Bruno elfin butterfly habitat is located well away from structures. However, there are historic coastal defense structures at Milagra Ridge near elfin butterfly habitat. Clearing of defensible space around coastal defense structures at Milagra Ridge would not occur in San Bruno elfin butterfly habitat (Mitigation Measure SS-28). Since no actions would occur, no impacts would result.

- **Mission Blue Butterfly.** Most mission blue butterfly habitat is on ridgetops well away from most structures. However, there are historic batteries and buildings at Fort Baker, the Marin Headlands, and Milagra Ridge in or adjacent to mission blue butterfly habitat. Clearing defensible space around batteries and buildings could result in the direct take of mission blue butterflies or essential habitat, including host and nectaring plants. Since these buildings are not common, impacts would be minor, although they would be long-term as treatments would be repeated.

- **Coho Salmon and Steelhead.** Coho salmon and steelhead would not be affected by clearing of defensible space around buildings unless work occurred in wetlands along streams or near Rodeo Lagoon. Mitigation measures require adequate buffer and erosion control measures when work is near streams or water bodies.

- **California Red-Legged Frog.** The California red-legged frog would not be affected by clearing of defensible space around buildings unless work occurred in wetlands in or adjacent to red-legged frog habitat. When work is near wetlands, surveying as required by Mitigation Measure SS-33 will occur and identify potential habitat, with short-term, negligible, adverse impacts.

- **Marbled Murrelet.** Marbled murrelets and their potential habitat at Muir Woods National Monument would not be significantly affected by clearing of defensible space unless breeding birds were present and disturbed by increased noise. Mitigation Measure SS-20 restricts noise-generating projects during the breeding season.

- **Northern Spotted Owl.** The creation of defensible spaces around structures would remove vegetation and disturb soil and litter, possibly affecting spotted owl prey. Although spotted owls are known to nest relatively close to roads, trails, and some buildings, much or their home range is typically in less developed areas of the park. Since there are typically not very many buildings located within spotted owl activity centers, impacts from prey reductions or disturbance would be

minor. Impacts would be minor, adverse, and long-term because treatments would need to be repeated. Mitigation Measure SS-14 restricts project actions within the range of nesting northern spotted owls, reducing long-term impacts to negligible.

- **Salt Marsh Harvest Mouse.** The salt marsh harvest mouse would not be affected by clearing of defensible space around buildings unless clearing occurred in potential habitat in wetlands at Rodeo or Bolinas Lagoons.

Roadside Fuel Reduction. Roadside fuel reduction would affect special status wildlife species as follows.

- **San Bruno Elfin Butterfly.** Fuel reduction along fire roads would not occur in San Bruno elfin butterfly habitat. Mitigation Measure SS-28 prohibits fire management actions in elfin butterfly habitat and no impacts would occur.

- **Mission Blue Butterfly.** Mission blue butterfly habitat occurs along several roads and trails in GGNRA. Reducing fuels along fire roads could result in the direct take of mission blue butterflies or essential habitat, including host and nectaring plants. Impacts would be adverse, long-term (because treatments would be repeated), and minor to moderate in extent. Mitigation Measure SS-22 would restrict roadside fuel reduction actions to outside the flight season. All lupine would be avoided year-round.

- **Tidewater Goby.** Indirect impacts on the tidewater goby may occur from increased sedimentation associated with improper maintenance of fire roads and trails in watersheds. Increased sedimentation may lead to the gradual conversion of estuarine habitat to upland habitats. With mitigation measures addressing erosion and site stabilization, such adverse impacts would be minor and these activities would have a beneficial, long-term, and minor effect on wetlands that support the tidewater goby by correcting existing sources of sediments.

- **Coho Salmon and Steelhead.** Improper maintenance of fire roads and trails in watersheds with listed salmonids may result in indirect, adverse impacts on salmonid habitat. Failure of plugged culverts may lead to debris flows in creeks that scour the channels. Fine sediments from fire roads may result in deposition in stream channels and reduce invertebrate productivity and the quality of spawning habitat. With mitigation, such adverse impacts would be addressed and would be short-term and minor to negligible.

- **California Red-Legged Frog.** Potential adverse impacts may result from roadside fuel treatment at locales where red-legged frogs and their habitat are present. These direct impacts may include injury or mortality if red-legged frogs are present during vegetation removal, mowing, and other related activities. With mitigation, which requires pre-approval surveys, flagging of habitat, and retention of vegetative cover, impacts would be reduced to a negligible level.

- **San Francisco Garter Snake.** Potential adverse impacts on San Francisco garter snakes and their prey (red-legged frogs) may result from roadside fuel reduction along fire roads and trails in parts

of San Mateo County. These direct impacts may include injury or mortality if red-legged frogs are present during vegetation removal, mowing, and other related activities. Use of fire roads and trails by motorized vehicles may also result in injury or mortality to snakes found on roads. With Mitigation Measures SS-5, SS-6, and SS-19, impacts would be reduced to a negligible level.

- **Northern Spotted Owl.** Roadside fuel reduction would remove vegetation and disturb soil and litter, possibly affecting the abundance of spotted owl prey. Habitat along these road/trail corridors is already disturbed by human activity and may be of lower quality for some prey species. Fire roads do occur within known spotted owl activity centers. Impacts would be adverse, long-term (because treatments would be repeated), and minor. Activity would be restricted to the non-breeding season and would not substantially alter canopy cover. Smaller-diameter trees would be removed to reduce fuels and woodrat nests would be avoided where feasible.

Suppression. Suppression actions would affect special status wildlife species as follows:

- **San Bruno Elfin Butterfly.** Disturbance from suppression activities could have adverse impacts on San Bruno elfin butterflies. Actions that can result in impacts include construction of fire lines, removal of vegetation, and water or retardant drops from aircraft, and staging. Creating fire lines could result in the direct take of San Bruno elfin butterflies or essential habitat, including host and nectaring plants. In addition, San Bruno elfin butterflies, their eggs, larvae, or host plants could be killed by water or retardant drops. Nonnative plants may adversely affect habitat following fire and/or ground disturbance. It is anticipated that applicable mitigations, which recommend avoidance of elfin butterfly habitat, would result in impacts occurring infrequently and would be short term in duration. Through Mitigation Measure SS-30, local fire agency staffs would be informed about areas of the park that support San Bruno elfin butterfly, with negligible long-term impacts.

- **Mission Blue Butterfly.** Disturbance from suppression activities could have adverse impacts on mission blue butterflies. Actions that can result in impacts include construction of fire lines, removal of vegetation, water or retardant drops from aircraft, and staging. Creating fire lines could result in the direct take of mission blue butterflies or essential habitat, including host and nectaring plants. In addition, mission blue butterflies, their eggs, larvae, or host plants could be killed by water drops. Saltwater drops could adversely affect mission blue butterfly habitat. It is anticipated that impacts would occur infrequently and be short-term in duration. Ground disturbance from wildfire and suppression activities could enhance mission blue butterfly habitat, or could result in adverse impacts on habitat as a result of nonnative plant response to fire and ground disturbance. Post-fire erosion could also have similar adverse or potentially beneficial impacts on mission blue butterfly habitat as a result of increased bare ground and substrate for establishment of host plants. Applicable mitigations such as Mitigation Measure SS-24, which informs local agencies about mission blue butterfly habitat, would minimize adverse impacts, and long-term impacts would be minor and beneficial with rehabilitation of habitat.

- **Tidewater Goby.** Current policies at GGNRA call for suppressing all unplanned ignitions using minimum impact suppression tactics as defined by National Wildfire Coordinating Group (NWCG). Potential adverse impacts may result from unmitigated wildland fire suppression activities. Actions that can result in impacts include water drafting, construction of fire lines, removal of vegetation, and staging. Mitigation measures addressing the tidewater goby (Mitigation Measure SS-32) are described in Chapter 2. With this mitigation, which recommends that local fire agencies avoid using Rodeo Lagoon water if possible, adverse impacts would be negligible and of short-term duration.

  Water drafting in Rodeo Lagoon could result in direct collection of gobies by either hoses or aerial buckets. Mortality would be expected once water is used to extinguish fires. The impacts would be greatest if drafting occurred along the shallow shorelines (water depths of less than 1 meter) where gobies typically concentrate.

- **Coho Salmon and Steelhead.** Current policies at GGNRA call for suppressing all unplanned ignitions using minimum impact suppression tactics as defined by National Wildfire Coordinating Group (NWCG). Potential adverse impacts on listed salmonids may result from unmitigated wildland fire suppression activities. The small streams that provide habitat for coho salmon and central California coast steelhead in the planning area are particularly vulnerable to the effects of fire because they are located in steep confined valleys. Actions that can result in impacts include water drafting, construction of fire lines, removal of woody debris and vegetation, and staging.

  Many of the GGNRA streams supporting salmonids are being used for municipal water supply. During dry years, naturally low summer and fall base flows plus water withdrawals have resulted in loss of juvenile salmonids. Additional water drafting to suppress fires could result in adverse impacts on juvenile salmonids.

  General measures to mitigate suppression impacts on critical habitat and listed salmonids are described in Chapter 2. These mitigations address water drawdown in salmonid streams if possible for suppression actions and post-suppression rehabilitation to avoid soil erosion. Impacts would be minor, adverse, and of short-term duration.

- **California Red-Legged Frog.** Potential adverse impacts on red-legged frogs may result from wildland fire suppression activities and are listed in Table 4-16. Actions that can result in impacts include water drafting, construction of fire lines, removal of woody debris and vegetation, and staging. Although these actions may have adverse effects on red-legged frogs, because of the small amount of acreage of wildfire each year, the effects are expected to be short-term and minor.

- **San Francisco Garter Snake.** San Francisco garter snakes may be adversely affected by fire suppression activities, including staging, fire line construction using heavy equipment, and operation of vehicles off established fire roads, that may crush individual snakes and burrows, particularly during fall and winter. Mitigation Measure SS-19 was developed in consultation with

the USFWS. Local fire agencies would be advised against vehicle use in red-legged frog habitat if at all possible in order to avoid these potential impacts on individual snakes and their habitat.

- **Marbled Murrelet.** Potential marbled murrelet habitat may be adversely affected during suppression activities by the felling of large coast redwood or Douglas-fir trees that could provide future nesting habitat. Impacts would be minor, long-term and adverse. Impacts would be reduced by Mitigation Measure SS-21, which calls for avoidance of tree felling in murrelet habitat. Long-term impacts would be negligible.

- **Western Snowy Plover.** Wildfire suppression activities on Ocean Beach could result in minor temporary impacts due to disturbance of snowy plovers as a result of an increase in the number of vehicles or aircraft above the beach or use of heavy equipment on the beach to reach remote areas or draw water.

- **California Brown Pelican.** Roosting brown pelicans could be adversely affected by disturbance from aircraft operations related to fire suppression, particularly in the Rodeo Beach (Bird Island), Rodeo Lagoon, and Bolinas Lagoon areas. Effects, with the application of Mitigation Measure SS-36, would be minor, short-term, and adverse.

- **Northern Spotted Owl.** Areas of high fuel loading make hotter fires or hot spots within lower-intensity prescribed burns more likely. These hotter fires can have adverse impacts on habitat by reducing canopy closure or destroying owl prey or their habitat. A large catastrophic wildfire in forested habitat could have long-term adverse impacts on spotted owls, their habitat, and potentially their prey base. Disturbance from suppression activities could have adverse impacts on spotted owls, particularly during the breeding season when suppression activities could cause spotted owls to abandon nesting attempts. In the recent past, the average annual acreage burned from wildfires in the park has been quite low, however, and any more than minor adverse impacts from the suppression of wildland fires would be unlikely.

  Small mammals, particularly the dusky-footed woodrat, that are important prey items for the northern spotted owl can be injured or killed when vehicles are traveling to sites or staging areas, or when bulldozers are constructing line. In addition, spotted owls or their prey could be injured or killed by water drops. It is anticipated that in most cases these impacts would occur infrequently. Personnel at fire camps or on suppression crews could provide a source of human food to wildlife, possibly attracting corvids or other nest predators that may depredate spotted owl nests. Impacts on spotted owls from spike camps are expected to be adverse, short-term, and minor. However, locating spike camps away from spotted owl activity centers and providing strict control of food and trash at camps can reduce these impacts. A natural resource advisor present at wildland fires, and incorporation of other applicable mitigation measures described in Chapter 2, would help avoid or reduce impacts from suppression activities.

- **Salt Marsh Harvest Mouse.** The salt marsh harvest mouse, if present at Rodeo or Bolinas Lagoons, could be adversely affected by wildland fire or fire suppression activities from drifting

smoke or actions that affect wetland habitat in these areas. Potential long-term impacts would be negligible.

Treatment of Muir Woods FMU. The fire management strategy for this FMU would affect special status wildlife species as follows:

- **Coho Salmon and Steelhead.** The Muir Woods FMU would be treated by a mix of prescribed fire, mechanical fuel reduction, and understory thinning projects. Both steelhead trout and coho salmon use Redwood Creek within the Muir Woods FMU for summer and winter rearing habitat as well as spawning habitat. Activities that could have adverse impacts include water drafting, construction of fire lines, removal of woody debris and vegetation, and staging actions. Impacts would be minor and short-term in duration with implementation of Mitigation Measures SS-11 through SS-13.

- **California Red-Legged Frog.** The Muir Woods FMU would contain a mix of prescribed fire, mechanical fuel reduction, and understory thinning projects. No red-legged frogs are known to use the Muir Woods FMU, although it is possible that it may be used by dispersing juveniles and adults during the nonbreeding season. No impacts are anticipated.

- **Marbled Murrelet.** Potential marbled murrelet habitat only occurs within the Muir Woods FMU. Fire management activities, including prescribed burning and mechanical fuel reduction, would not adversely affect these species over the long term since these actions would be focused on protecting and enhancing the coast redwood and Douglas-fir trees and forest stands that provide nesting habitat for this species With applicable mitigation measures regarding burn timing to avoid nesting seasons, avoiding felling large trees during suppression activities, and minimizing noise generation in the summer from mechanized equipment, overall impacts on this species would be beneficial, minor, and long-term (see Mitigation Measures SS-20 and SS-21 in Chapter 2).

- **Northern Spotted Owl.** As long as fire actions are conducted outside the breeding season and fall within the constraints listed in Mitigation Measures SS-14 through SS-18 in Chapter 2, fire actions would not have significant adverse impacts, and could have beneficial impacts on the northern spotted owl. Spotted owls would benefit from the reduced risk of catastrophic fire. In addition, spotted owls may benefit from the opening of densely forested areas that may enhance their foraging efficiency or the abundance of their preferred prey, with resultant long-term, negligible-to-minor beneficial impacts.

Treatment of San Francisco County Project Area. There would be no beneficial or adverse effect on any special status wildlife species from fuel reduction strategies for San Francisco lands. Only the western snowy plover occurs in San Francisco, and no fuel reduction activities are proposed for Ocean Beach.

Public Information and Fire Education Programs. There would be no direct beneficial or adverse effect on any special status wildlife species from the public information and education program.

Fire Cache. There would be no beneficial or adverse effect on special status wildlife species from the fire cache relocation.

Fire Effects Monitoring. Fire effects monitoring would affect special status wildlife species as follows.

- **San Bruno Elfin Butterfly.** Some trampling and disturbance would be associated with fire effects monitoring, although these would be infrequent, of short duration, and minor in intensity. Monitoring would likely be conducted during San Bruno elfin flight season since that is the active growing season, but its host plant's habit of growing on rocky outcrops in dense stands of poison oak would limit the likelihood and intensity of impacts, since rock outcrops and barren areas are excluded from consideration when Fire Monitoring Handbook (FMH) plots are being established. *Sedum spathulifolium* is easily identified and trampling avoided. The knowledge gained through fire effects monitoring would be beneficial to developing increased knowledge of San Bruno elfin butterfly habitat and its response to wildfire or prescribed fire. This information would be used to guide future fire management activities in elfin butterfly habitat.

- **Mission Blue Butterfly.** Some trampling and disturbance would be associated with vegetation sampling, although these would be infrequent and of short duration and minor intensity. Vegetation sampling would likely be conducted during mission blue butterfly flight season, since that is the active growing season. Host plants are easily identified during the active growing season and trampling of lupine is easily avoided. The knowledge gained through fire effects monitoring would be beneficial to developing better understanding of mission blue butterfly habitat and its response to wildfire or prescribed fire. This information would be used to guide future fire management activities in mission blue butterfly habitat.

- **Northern Spotted Owl.** The knowledge gained through fire effects monitoring would be beneficial to developing better understanding of spotted owl habitat and its response to wildfire or prescribed fire. This information would be used to guide future fire management activities in spotted owl habitat. No adverse impacts on the northern spotted owls or their habitat are anticipated from fire effects monitoring activities.

Alternative A

Mechanical Fuel Reduction. Under Alternative A, mechanical fuel reduction would affect special status wildlife species as follows.

- **San Bruno Elfin Butterfly.** Mechanical fuel reduction techniques, such as mowing, brush clearing and tree removal, could have some adverse impacts on San Bruno elfin butterflies. Removing vegetation could result in the direct take of San Bruno elfin butterflies or essential habitat, including host and nectaring plants.

  Conversely, mechanical removal of trees and brush to attain target conditions may enhance habitat for San Bruno elfin butterflies by reducing threats from nonnative plants and catastrophic fire, especially from human-caused ignitions that occur in developed areas. When cut vegetation cannot be burned onsite or removed, it may be chipped and distributed over the site. When chips

are spread deeply enough to affect the growth of native plants, San Bruno elfin butterfly foraging may be adversely affected. Goats would eat *Sedum spathulifolium* and other plants that serve as nectar sources. Mitigation Measure SS-28 restricts planned fire management action from areas supporting San Bruno elfin butterfly habitat. Mitigation Measure SS-29 restricts fire management actions from potential San Bruno elfin butterfly habitat. With mitigation, adverse impacts would be minor and short-term, and potential beneficial impacts from reduced risk of catastrophic wildfire and removal of nonnative vegetation would be minor and long-term.

- **Mission Blue Butterfly.** Mechanical fuel reduction techniques, such as mowing, brush clearing and tree removal, could have some adverse impacts on mission blue butterflies. Removing vegetation could result in the direct take of mission blue butterflies or essential habitat, including host and nectaring plants. Conversely, mechanical removal of trees and brush to attain target conditions would enhance habitat for mission blue butterflies by promoting open, unshaded, grassland/coastal scrub habitat and reducing the threat of catastrophic fire, especially from human-caused ignitions that occur in developed areas. When cut vegetation cannot be burned onsite or removed, it may be chipped and distributed over the site. When chips are spread deeply enough to affect the growth of native plants, mission blue butterfly foraging may be adversely affected. Goats would eat lupine and other plants that serve as nectar sources, but the grazing disturbance may benefit lupine in the long term. A maximum of 95 acres would be treated mechanically under Alternative A in Marin and San Mateo counties. Adverse impacts from site disturbance and vegetation removal would be minor and short-term, with long-term beneficial impacts through expansion of mission blue butterfly habitat in the Marin County.

- **Tidewater Goby.** Mechanical fuel reduction techniques, such as mowing, brush clearing and tree removal, could have negligible adverse impacts on tidewater goby as a result of increased sedimentation and vegetation removal in riparian areas and stream corridors. Few acres would be treated in or adjacent to tidewater goby habitat at Rodeo Lagoon. With mitigation, adverse impacts would be negligible. Only hand treatment (no large mechanized equipment) would be used to conduct vegetation removal (e.g., removal of individual trees) in riparian habitat to minimize soil disturbance.

- **Coho Salmon and Steelhead.** Mechanical fuel reduction techniques, such as mowing, brush clearing and tree removal, could have some adverse impacts on coho salmon and steelhead as a result of increased sedimentation and vegetation removal in riparian areas and stream corridors. Only hand treatment (no large mechanized equipment) would be used to conduct vegetation removal (e.g., removal of individual eucalyptus trees) in riparian habitat to minimize soil disturbance. Only a very small proportion of acres to be treated would be in or adjacent to salmonid habitat. With mitigation, impacts would be minor and short-term, with long-term beneficial impacts from restoration of riparian habitat.

- **California Red-Legged Frog.** Mechanical fuel reduction activities such as mechanical tree removal, vegetation clearing, and understory thinning could disturb frogs or alter their habitat. However, the majority of mechanical fuel reduction activities would be conducted outside areas

typically considered as either breeding or non-breeding habitat (e.g., emergent marshes and stream riparian corridors). This treatment would be used in very small areas of potential red-legged frog habitat near buildings to create defensive space; otherwise, breeding habitat of red-legged frogs would not be treated. Reduction in fuel loading by hand thinning or mechanical treatment would have a beneficial effect on red-legged frogs by reducing fuel loads and the threat of catastrophic fire that could back into wetland and creek habitats. Mechanical treatments may inadvertently kill red-legged frogs, an impact that would be adverse but short-term and minor. With Mitigation Measures SS-5, SS-6, and SS-33 through SS-35, impacts would be reduced to a negligible level.

- **San Francisco Garter Snake.** San Francisco garter snakes may be adversely affected by mechanical fuel reduction activities, including vegetation removal in wetland habitat and operation of heavy equipment and vehicles off of established fire roads, that may crush individual snakes and burrows, particularly during fall and winter. It is expected that only a small proportion of the acres treated would be in or adjacent to San Francisco garter snake habitat. With Mitigation Measures SS-5, SS-6, and SS-19, adverse impacts would be minor and short-term.

- **Marbled Murrelet.** Marbled murrelet potential habitat only occurs within Muir Woods. Mitigation Measures SS-20 and SS-21, which address concerns about noise generation and the felling of trees, would apply under all alternatives and was addressed in the "Actions Common to All Alternatives" section. Long-term, minor, beneficial impacts would result.

- **California Brown Pelican.** The only actions potentially associated with mechanical fuel reduction that may adversely affect California brown pelican roosting areas at Rodeo or Bolinas Lagoons would be potential use of helicopters for tree removal. Mitigation Measure SS-38 recommends that aircraft avoid pelican roosting areas seasonally. Impacts would be short-term, minor, and adverse.

- **Northern Spotted Owl.** Mechanical fuel reduction techniques, such as mowing, brush clearing, and tree removal, could have adverse impacts on spotted owls and their prey species. With mitigation, adverse impacts on their primary food source, the dusky-footed woodrat, would be short-term and minor. Adverse impacts from disturbance to nesting spotted owls would be negligible following mitigation.

  When cut vegetation cannot be burned onsite or removed, it may be chipped and distributed over the site. When chips are spread deeply enough to affect the growth of native plants, spotted owl prey species could be adversely affected. Standard practice for chipping directs chips to be spread as thinly as possible on the site – usually to a depth of not more than 1 inch. Impacts on spotted owls from chipping would therefore be negligible, adverse, and short-term.

  Mechanical removal of trees and brush to attain target conditions would have beneficial impacts on spotted owls by enhancing native habitat and reducing the threat of catastrophic fire, especially from human-caused ignitions that occur in developed areas. Brush clearing may also increase foraging opportunities for spotted owls. Restoration of native plant communities would

also have beneficial indirect impacts on spotted owls by improving conditions for native prey species.

- **Salt Marsh Harvest Mouse.** Mechanical fuel reduction techniques, such as mowing, brush clearing, and tree removal, could have minimal adverse impacts on potential salt marsh harvest mouse habitat as a result of increased sedimentation and vegetation removal in wetland areas. Only a small portion of GGNRA acreage is expected to be in or adjacent to potential salt marsh harvest mouse habitat at Rodeo or Bolinas Lagoons. With mitigation, adverse impacts would be negligible. To minimize soil disturbance, only hand treatment (no large mechanized equipment) would be used to conduct vegetation removal (e.g., removal of individual trees) in riparian habitat.

Pile Burning. Pile burning under Alternative A would affect special status wildlife species as follows.

- **San Bruno Elfin Butterfly.** Piling and burning of downed trees and shrubs could have adverse impacts on San Bruno elfin butterflies. Fire crews, or the actual piles, could kill *Sedum spathulifolium* host plants, including San Bruno elfin butterfly eggs or larvae. Mitigation Measure SS-28 prohibits fire management actions within San Bruno elfin butterfly habitat, so no impacts would occur.

- **Mission Blue Butterfly.** Piling and burning of downed trees and shrubs could have adverse impacts on mission blue butterflies. Fire crews, or the actual piles, could kill lupine host plants, including mission blue butterfly eggs or larvae. The pile-burning methodology should prevent overly hot fires that could sterilize soils and have long-term impacts. With Mitigation Measure SS-23, pile burning would be restricted to barren, disturbed soils, and impacts would be negligible.

- **Coho Salmon and Steelhead.** Pile burning would result in bare areas and ash. If located next to a creek channel, ash would be delivered to streams under wet weather conditions. General mitigation measures for water quality would provide protection along the channel and minimize the areal extent of bare area caused by burn piles. With mitigation, impacts would be short-term, adverse, and negligible.

- **California Red-legged Frog.** Frogs may shelter in piles and be killed when the piles are burned. The impact on the park's frog population would be no more than negligible, however, because breeding areas and adjacent non-breeding areas would be identified and avoided before any pile burning is undertaken. Although pile burning would occur in both Marin and San Mateo counties, none would occur in wetland habitat. With mitigation, impacts would be negligible.

- **San Francisco Garter Snake.** San Francisco garter snakes may shelter in piles and be killed when the piles are burned. The impact on the park's San Francisco garter snake population would be negligible, however, because San Francisco garter snake and red-legged frog habitat would be identified and avoided before any pile burning is undertaken. Although pile burning would occur

in both Marin and San Mateo counties, none would occur in wetland habitat. With mitigation, impacts would be negligible.

- **Northern Spotted Owl.** Piling and burning of downed trees and shrubs may have an adverse effect on some spotted owl prey. Some species, such as small rodents, may take up residence in burn piles between the time the piles are stacked and the time they are burned, which can be several months. Many of these animals are likely to escape fire once the piles are ignited, but some may perish. The pile-burning methodology described in Mitigation Measure WIL-4 should prevent overly hot fires that could sterilize soils over larger areas, and have long-term impacts. Impacts from pile burning would be short-term, adverse, and minor.

Prescribed Burning. Prescribed burning under Alternative A would affect special status wildlife species as follows.

- **San Bruno Elfin Butterfly.** Prescribed fire would reduce the threat of catastrophic unplanned wildfire and the potential for long-term destruction of San Bruno elfin butterfly habitat. Fires would kill San Bruno elfin eggs and larvae in the burn area. Control actions at the boundaries of prescribed fires, such as the removal of vegetation to construct fire lines, would have adverse, long-term, and minor impacts on San Bruno elfin butterfly habitat. Because very little is known about the response of San Bruno elfins to fire, no prescribed burns would be conducted in San Bruno elfin butterfly habitat and a buffer will be maintained around potential habitat. Prescribed fires in adjacent habitat would have negligible short-term impacts.

- **Mission Blue Butterfly.** Prescribed fire may be an effective tool in protecting and improving mission blue butterfly habitat in the park by helping to reduce unnatural accumulations of fuels, by preventing the encroachment of shrubs into coastal grasslands, and possibly by providing a disturbance that benefits host lupine plants. Prescribed fire would reduce the threat of catastrophic unplanned wildfire and the potential for long-term destruction of mission blue butterfly habitat. Fires would directly kill mission blue butterfly eggs and larvae in the burn area. Because very little is known about the response of mission blue butterflies to fire, only research burns would be conducted in existing mission blue butterfly habitat. With mitigation, any prescribed fires in lands adjacent to habitat would have negligible short-term adverse impacts and long-term moderate beneficial impacts.

- **Tidewater Goby.** Prescribed burning could increase the amount of exposed bare ground that is susceptible to erosion and deposition into Rodeo Lagoon. Only a very small proportion of those acres would be close to Rodeo Lagoon. With mitigation for erosion control, adverse impacts would be short-term and minor.

- **Coho Salmon and Steelhead.** GGNRA would adhere to the mitigation measures described in Chapter 2 when working in salmonid habitat. Despite these mitigation measures, prescribed burning could result in increased turbidities in some streams or creeks in the park. Vegetation in the burned areas would return quickly and sediment loss would slow over time. In addition, if upon review of a particular burn plan by park specialists, turbidity increases for coho or steelhead

are considered a possible moderate or major adverse impact of prescribed burning, the burn may be cancelled or a series of mitigation measures put in place to bring sediment levels down.

To minimize impacts from erosion and assure that anadromous salmonid species are protected, Mitigation Measure SW-1 would be implemented. This mitigation measure requires that subject matter experts ensure that associated erosion control plans are sufficient to prevent long-term moderate or major impacts on the rate of soil erosion. In other words, the expert would determine whether the proposed erosion control strategy would be sufficient to ensure no greater than minor impacts on salmonids from erosion or impacts on the riparian corridor. If the assessment finds that standard setbacks would be insufficient to avoid a long-term moderate or major effect on the salmonid habitat, wider buffers or staggered burning regimes would be implemented. Some of the strategies used to minimize impacts on soils are to avoid steep slopes, time burns to maximize favorable environmental conditions, and use erosion control devices during burns.

Coho salmon and steelhead trout appear to be stable under the current GGNRA management, including fire management actions that have been conducted over the past several years and that would be continued under Alternative A. Prescribed fire, because it is used to restore the natural vegetation structure of park habitats and reduce the risk of catastrophic fire, would have a long-term benefit by protecting dense riparian habitat, keeping water temperature in appropriate ranges, and controlling sediment loading to the stream for these two species.

Potential adverse impacts from prescribed burning may result from staging activities, construction of fire lines, and removal of woody debris and vegetation through burning. With mitigation, impacts would be minor and short-term in duration and adverse.

- **California Red-legged Frog.** Prescribed fire, because it is used to restore the natural vegetation structure in park habitats and reduce the risk of catastrophic fire, would have long-term benefits to red-legged frogs and their habitat. These benefits, however, would be limited by the relatively small area that would be burned annually under Alternative A.

  High levels of fuel loading in some areas may cause prescribed fires to burn at higher than natural intensities, even when fire prescriptions were designed to minimize high-intensity fires. Hotter fires, or fires that may more readily burn unintended areas, could burn riparian habitat. Higher-intensity burns could also result in increased sedimentation in frog habitat. With mitigation, adverse impacts associated with prescribed burning would be short-term and minor. Improvement of habitat through prescribed burning would result in a long-term, beneficial effect.

- **San Francisco Garter Snake.** Prescribed fire, because it is used to restore the natural vegetation structure in park habitats and reduce the risk of catastrophic fire, would have long-term benefits to San Francisco garter snakes, their habitat, and their primary prey, red-legged frogs. San Francisco garter snakes may be adversely affected by prescribed fire activities, including burning of vegetation and operation of heavy equipment and vehicles off of established fire roads, that may crush individual snakes and burrows, particularly during fall and winter. It is expected that only a small proportion of the acres treated would be in or adjacent to potential San Francisco

garter snake habitat. With Mitigation Measures SS-5, SS-6, and SS-19, adverse impacts would be minor and short-term. Long-term impacts would be negligible, beneficial effects due to reduction of wildfire hazard risk.

- **Marbled Murrelet.** Marbled murrelet potential habitat only occurs within Muir Woods. Treatment of Muir Woods would be the same under all alternatives and was addressed in the "Actions Common to All Alternatives" section.

- **California Brown Pelican.** No prescribed fire is planned to occur within areas used by brown pelicans for roosting at Rodeo Lagoon or Bolinas Lagoon. Negligible impacts on roosting birds may occur as a result of drifting smoke.

- **Northern Spotted Owl.** Prescribed fire can be an effective tool in protecting and improving spotted owl habitat in the park by helping to reduce unnatural accumulations of fuels and ladder fuels. Spotted owls can coexist with extensive fires of varying intensities within their habitats (Weatherspoon et al. 1992). Prescribed fire would reduce the threat of catastrophic unplanned wildfire and the long-term destruction of spotted owl habitat. Under Alternative A, prescribed fire would have beneficial, long-term, and minor impacts on some wildlife species by providing patchy open or early seral stage habitat that may enhance spotted owl foraging in areas of GGNRA most severely altered by fire suppression. Conversely, some spotted owl prey that depend on down wood, dense forests, and ground cover, such as small mammals and ground-nesting birds, would experience localized adverse impacts in the treated areas from displacement – although prescribed fire would also create some new sources for downed dead wood. Any prescribed burning would be conducted outside of the nesting period per Mitigation Measure SS-14. Control actions at the boundaries of prescribed fires, such as the removal of vegetation to construct fire lines, would have short-term, minor, adverse effects, though overall this alternative would have a long-term, minor, beneficial effect on northern spotted owl habitat.

- **Salt Marsh Harvest Mouse.** Prescribed burning could increase the amount of exposed bare ground that is susceptible to erosion and deposition into Rodeo and Bolinas Lagoons. Only a small proportion of those acres would be close to Rodeo or Bolinas Lagoons. With mitigation, adverse impacts would be short-term, negligible, and adverse.

Research. Alternative A would include an element of research into the effects of fire on natural resources. Research under this alternative would lead to better management of native plant communities through the use of fire as a tool to move toward desired conditions. Overall, research would have a beneficial impact, as the results could inform future decision making related to management of habitat for threatened and endangered wildlife species. Since these research burns would be synonymous with the prescribed burning described above, the same mitigations would be applied to protect threatened and endangered wildlife, and the possible adverse impacts would be the same. Overall impacts on threatened and endangered wildlife would be beneficial, long-term, and minor to moderate.

Cumulative Impacts. Other actions combined with Alternative A would have the following effects on special status wildlife species.

- **San Bruno Elfin Butterfly.** The Trails Forever projects, habitat restoration programs, maintenance operations, and potentially some Wildland-Urban Interface Initiative projects adjacent to the park would have the potential to affect the San Bruno elfin butterfly and its habitat in San Mateo County. Since San Bruno elfin butterfly habitat in the park is mapped and monitored on a regular basis, the habitat would be considered and avoided during in-park projects and operations, particularly since it occurs primarily in relatively inaccessible patches on rocky outcrops. Cumulative adverse impacts would be short-term and negligible to minor. Other ongoing programs, including nonnative plant removal projects within the park as well as Wildland-Urban Interface Initiative projects on adjacent parklands, may result in long-term beneficial effects by preventing nonnative vegetation from displacing San Bruno elfin habitat.

- **Mission Blue Butterfly.** The Marin Headlands/Fort Baker Roadway Improvement and Transportation Management Plan, Trails Forever projects, the Fort Baker EIS, Marin County fire management activities, San Francisco Watershed Plan implementation, Wildland-Urban Interface Initiative projects, habitat restoration programs, and maintenance operations all have the potential to affect the Mission blue butterfly and its habitat in Marin and San Mateo counties. The Fort Baker EIS and habitat restoration programs will have significant long-term beneficial effects through restoration and expansion of mission blue butterfly habitat and control of nonnative vegetation. Trails Forever projects, the Transportation Management Plan, maintenance operations, and other agency projects may have moderate-to-major short and/or long-term adverse impacts associated with them that would require substantial mitigation to minimize effects to mission blue butterfly habitat in Marin and San Mateo counties.

- **Tidewater Goby.** The Marin Headlands/Fort Baker Roadway Improvement and Transportation Management Plan, Trails Forever projects, habitat restoration programs, maintenance, structural fire operations, and the proposed Giacomini wetlands restoration project have the potential to affect the tidewater goby and its habitat. The transportation plan may beneficially affect the tidewater goby through slight increases in habitat and substantially reduced sediment and contaminant input into Rodeo Lagoon. Habitat restoration programs are restoring riparian and wetland vegetation along the shoreline. Implementation of best management practices for park maintenance operations and improved facilities for vehicle washing at the fire station at Rodeo Beach will also reduce sedimentation and improve water quality in the lagoon. Tidewater gobies were recently rediscovered on the Giacomini Ranch in areas proposed for tidal wetland restoration. Studies are ongoing to determine habitat requirements and protect and expand the population during the restoration project.

- **Coho Salmon and Steelhead.** Big Lagoon restoration (Redwood Creek watershed), interim flood control actions in Muir Beach, the Comprehensive Transportation Management Plan (CTMP), Trails Forever projects, implementation of the PRNS FMP, Wildland-Urban Interface Initiative projects, habitat restoration programs, and maintenance operations all have the potential to affect coho salmon and/or steelhead and critical habitat.

- **California Red-Legged Frog.** Big Lagoon restoration (Redwood Creek watershed), interim flood control actions in Muir Beach, the Comprehensive Transportation Management Plan (CTMP), Trails Forever projects, implementation of the PRNS FMP, the proposed Giacomini wetland restoration project, Wildland-Urban Interface Initiative projects, habitat restoration programs, and maintenance operations all have the potential to affect the California red-legged frog and its habitat. Interim flood control actions at Muir Beach resulted in unauthorized take of red-legged frogs; formal Section 7 consultation and mitigation measures are currently being initiated to address this take and prevent future occurrences. The Big Lagoon restoration project is proposing to create additional red-legged frog habitat in advance of project implementation. Habitat restoration and maintenance operations seek to avoid impacts on red-legged frogs. The Giacomini wetland restoration project is carefully evaluating alternatives for protection/enhancement of red-legged frog habitat during project planning.

- **San Francisco Garter Snake.** Trails Forever projects, habitat restoration programs (including a proposed project to enhance wetlands at Mori Point for the garter snake and California red-legged frogs), maintenance operations, illegal poaching, interim planning for new GGNRA lands in San Mateo County, as well as the importation of sand and proposed repairs to the Sharp Park golf course by the San Francisco Recreation and Park Department, all have potential to affect San Francisco garter snake habitat in San Mateo County. Trails Forever projects, habitat restoration activities, and interim planning for new lands in San Mateo County are actively working to protect and enhance San Francisco garter snake habitat in cooperation with the U.S. Fish and Wildlife Service.

- **Marbled Murrelet.** Catastrophic wildfire and increasing populations of corvids (ravens, crows, and jays) – all likely related to human-induced changes in the environment – may adversely affect potential marbled murrelet habitat in Marin County. Fire management activities are planned to reduce the risk of catastrophic wildfire.

- **Western Snowy Plover.** Maintenance operations, continued expansion of European beach grass, illegal off-leash dogs, and the Ocean Beach erosion control/managed retreat proposed project have the potential to affect the western snowy plover and its non-breeding habitat on Ocean Beach. The impact of erosion control/managed retreat measures on snowy plovers will be evaluated during project planning. GGNRA continues to enforce the leash law on Ocean Beach but the vast expanse of beach makes this a challenging task.

- **California Brown Pelican.** Intense visitor use of Rodeo Beach, the CTMP, Trails Forever projects, recreational boating on Bolinas Lagoon and near Bird Island, illegal off-leash dogs, the proposed Bolinas Lagoon ecological restoration project, and aircraft overflights have the potential to affect important California brown pelican roosting sites at Bird Island, Rodeo Beach and Lagoon, and Bolinas Lagoon. The CTMP is considering trail reroutes to reduce disturbance to brown pelicans on Rodeo Beach. The Bolinas Lagoon ecological restoration project will include consideration of pelican roosting and foraging habitat needs, and Marin County Open Space District rangers and the Sheriff Department monitor recreational boating on Bolinas Lagoon to

minimize wildlife impacts. The future Air Tour Management Plan to be prepared by the Federal Aviation Administration for GGNRA will consider impacts of air tours on park wildlife.

- **Northern Spotted Owl.** The CTMP, Trails Forever projects, implementation of the PRNS FMP, Wildland-Urban Interface Initiative projects, habitat restoration programs, and maintenance operations all have the potential to affect the northern spotted owl in Marin County. All of these plans, projects, and activities consider spotted owls in their planning and implementation, thus minimizing impacts, particularly during breeding season. Catastrophic wildfire, Sudden Oak Death (caused by an introduced pathogen), increasing populations of corvids (ravens, crows, and jays), expansion in the range of barred owls – all likely related to human-induced changes in the environment – may adversely affect spotted owls in Marin County. Fire management activities and research into fire effects on Sudden Oak Death may reduce the threat from these sources. Corvids and barred owls are more difficult to manage effectively.

- **Salt Marsh Harvest Mouse.** The Marin Headlands/Fort Baker Roadway Improvement and Transportation Management Plan, Trails Forever projects, habitat restoration programs, maintenance operations, and the proposed Bolinas Lagoon ecological restoration project may affect potential salt marsh harvest mouse habitat at Rodeo and Bolinas lagoons. The transportation plan may beneficially affect the availability of salt marsh harvest mouse through slight increases in habitat and substantially reduced sediment and contaminant input into Rodeo Lagoon. Habitat restoration programs are restoring riparian and wetland vegetation along the shoreline.

Conclusion. In summary, Alternative A would have the following effects on special status wildlife species.

- **San Bruno Elfin Butterfly.** Flexible fire suppression has the potential for numerous short-term, adverse impacts on San Bruno elfin butterflies. These adverse impacts are expected to be minor based on the limited number of wildfires that have occurred annually in the park. Compared with suppression actions, however, preventing a catastrophic fire in the park probably offers a greater long-term benefit to the park's San Bruno elfin butterflies. The impacts of community projects funded by the federal Wildland-Urban Interface Initiative would be beneficial, long-term, and minor. The public information and education program and fire behavior monitoring program would have beneficial, long-term, and minor impacts on the park's San Bruno elfin butterflies.

  Mechanical fuel reduction, prescribed burning, pile burning, and research burns would not occur directly in areas supporting San Bruno elfin butterfly habitat, but may occur in adjacent habitat. With mitigation, adverse impacts would be negligible to minor and short-term. Potential beneficial impacts from reduced risk of catastrophic wildfire and removal of nonnative vegetation would be minor and long-term.

- **Mission Blue Butterfly.** Flexible fire suppression has the potential for numerous short-term, adverse impacts on mission blue butterflies. These adverse impacts would be minor based on the limited number of wildfires that occur annually in the park. Compared with suppression actions,

however, preventing a catastrophic fire in the park probably offers a greater long-term benefit to the park's mission blue butterflies. Having the flexibility to allow some wildfires in the park interior to burn to enhance natural resources would benefit wildlife, but is not a feasible option with the proximity of neighboring communities to all areas of the park. The impacts of community projects funded by the federal Wildland-Urban Interface Initiative would be beneficial, long-term, and minor. Clearing defensible space around structures and roadway fuel reductions would have long-term, adverse, and minor-to-moderate impacts on mission blue butterflies. The public information and education program, fire cache relocation, and fire behavior monitoring program all would have beneficial, long-term, and minor impacts on the park's mission blue butterflies.

Adverse impacts mission blue butterflies and their habitat from site disturbance and vegetation removal associated with mechanical fuel reduction and prescribed fire would be minor and short-term following mitigation, with moderate, long-term, beneficial impacts through protection and expansion of mission blue butterfly habitat. Pile burning would not be conducted in mission blue butterfly habitat; impacts would be negligible. Only research burns would be conducted in mission blue butterfly habitat supporting host plants. Research burns conducted in existing mission blue butterfly habitat would have short to long-term adverse impacts on mission blue butterflies by killing their eggs or larvae. Burning less than 5 percent of existing habitat in any one year, under an approved research plan, would minimize impacts. Research burns may result in long-term beneficial effects on mission blue butterflies by returning the site to a more favorable early seral stage and potentially reducing fungal pathogens that periodically cause significant die-back of host plants.

- **Tidewater Goby.** Adverse impacts from mechanical fuel reduction, prescribed burning, pile burning, and fire research would be short-term and negligible to minor following mitigation, since none of these activities would occur directly within tidewater goby habitat.

- **Coho Salmon and Steelhead.** Mechanical fuel reduction would result in short-term, minor adverse impacts resulting from potential disturbance to soils and vegetation in riparian areas, with long-term beneficial impacts from restoration of riparian habitat through removal of nonnative trees. Potential adverse impacts of prescribed burning and research burns would be reduced to minor and short-term through appropriate mitigation. Pile burning would not be conducted in riparian areas, thus resulting in negligible impacts on coho and steelhead.

- **California Red-Legged Frog.** Mechanical fuel reduction, prescribed fire, and research burns may result in short-term, negligible-to-minor adverse impacts related to disturbance in or adjacent to red-legged frog habitat, and long-term, minor beneficial impacts by reducing the threat of catastrophic wildfire that could adversely affect wetland habitat. Pile burning would not be conducted in wetland habitat; associated impacts would be negligible.

- **San Francisco Garter Snake.** Mechanical fuel reductions, use of prescribed fire, research burns, associated vegetation removal, and heavy equipment operation have the potential for adverse, minor, short-term impacts on the San Francisco garter snake following mitigation. Long-term,

minor beneficial impacts would result from these actions by reducing the threat of catastrophic wildfire that could adversely affect garter snake habitat. Pile burning would not be conducted in wetland habitat and San Francisco garter snake habitat would be avoided; associated impacts would be negligible.

- **Marbled Murrelet.** Impacts on marbled murrelets are addressed in the "Actions Common to All Alternatives" section above. Impacts would be mitigated by Mitigation Measure SS-20, which limits actions to non-nesting months and less sensitive periods of the day. Mitigation Measure SS-21 preserves large diameter trees in murrelet habitat. Impacts are limited to projects in the Muir Woods FMU and would be negligible.

- **Western Snowy Plover.** The only potential impacts on western snowy plovers would be from suppression activities that are common to all alternatives. Plovers would not be affected by any other actions in Alternative A.

- **California Brown Pelican.** By avoiding use of helicopters for mechanical fuel reduction in areas adjacent to Bird Island and Rodeo and Bolinas Lagoons, impacts on roosting brown pelicans would be negligible. Impacts from drifting smoke during prescribed burns, pile burning, or research burns would also be negligible, adverse, and short-term.

- **Northern Spotted Owl.** Flexible fire suppression has the potential for numerous short-term, adverse impacts on spotted owls. These adverse impacts are expected to be minor based on the limited number of wildfires that occur annually in the park. Compared with suppression actions, however, preventing a catastrophic fire in the park probably offers a greater long-term benefit to the park's wildlife. Having the flexibility to allow some wildfires in the park interior to burn to enhance natural resources would benefit wildlife, but is not a feasible option with the close proximity of neighboring communities to all areas of the park. The fire management strategy for Muir Woods would provide long-term benefits to spotted owls, mainly associated with restoring fire to the ecosystem, which outweigh some of the adverse impacts of mechanical removals and prescribed fire. The impacts of community projects funded by the federal Wildland-Urban Interface Initiative would be beneficial, long-term, and minor. Clearing defensible space around structures and reducing roadway fuel would have long-term, adverse, minor impacts on spotted owls. The public information and education program, fire cache location, and fire behavior monitoring program all would have beneficial, long-term, and minor impacts on the park's spotted owls.

  Adverse impacts associated with vegetation removal and disturbance during mechanical fuel reduction, prescribed fire, and research burns, as well as pile burning, would be minor and short-term following mitigation. Long-term, minor beneficial impacts on spotted owls and their prey would result from native habitat restoration and enhancement and the reduced threat of catastrophic wildfire.

- **Salt Marsh Harvest Mouse.** Adverse impacts from mechanical fuel reduction, prescribed burning, pile burning, and fire research would be short-term and negligible to minor following

mitigation, since none of these activities would occur directly within potential salt marsh harvest mouse habitat.

Impairment. No impairment to any threatened and endangered species would occur under Alternative A.

Alternative B

Mechanical Fuel Reduction. Under Alternative B, mechanical fuel reduction would affect special status wildlife species as follows.

- **San Bruno Elfin Butterfly.** Impacts would be similar to those described for Alternative A. No areas supporting San Bruno elfin butterfly habitat would be targeted for mechanical fuel reduction per mitigation measure SS-28. Impacts and mitigations would be the same as described for Alternative A.

- **Mission Blue Butterfly.** Impacts would be similar to those described for Alternative A, with a slight increase in the extent of impacts as the amount of land that could be treated under Alternative B is more than twice that of Alternative A. Adverse impacts from site disturbance and vegetation removal would still be minor and short-term, with potential for greater long-term beneficial impacts through expansion of mission blue butterfly habitat in the Marin County. Mitigations would be the same as described for Alternative A.

- **Tidewater Goby.** Of the acres identified to be treated mechanically in Marin County annually under Alternative B, little to none are expected to be in or adjacent to tidewater goby habitat at Rodeo Lagoon. Impacts and mitigations would be the same as described for Alternative A.

- **Coho Salmon and Steelhead.** Impacts would be similar to those described for Alternative A, with a slight increase in the extent of impacts as the amount of land that could be treated under Alternative B is more than twice that of Alternative A. However, only a small proportion of the treated acres would include or adjoin salmonid habitat. Adverse impacts from site disturbance and vegetation removal would still be minor and short-term, with potential for greater long-term beneficial impacts through restoration of riparian habitat by removal of nonnative vegetation. Mitigations would be the same as described for Alternative A.

- **California Red-Legged Frog.** The majority of mechanical fuel reduction activities called for in Alternative B would be conducted outside areas typically considered as either breeding or nonbreeding habitat (e.g., emergent marshes and stream riparian corridors). Impacts and mitigations would be the same as described for Alternative A.

- **San Francisco Garter Snake.** It is expected that only a small proportion of the acres to be treated in Alternative B would include or adjoin San Francisco garter snake habitat. Impacts and mitigations would be the same as described for Alternative A.

- **Marbled Murrelet.** Potential marbled murrelet habitat only occurs within Muir Woods. Treatment of Muir Woods would be the same under all alternatives and is addressed in the

"Actions Common to All Alternatives" section above. With the identified mitigations, adverse impacts on marbled murrelets and their habitat would be negligible, and long-term impacts would be beneficial because the risk of catastrophic wildfire in old-growth forest would be reduced.

- **California Brown Pelican.** The only actions potentially associated with mechanical fuel reduction that may adversely affect California brown pelican roosting areas at Rodeo or Bolinas Lagoons would be use of helicopters for tree removal. Impacts and mitigations would be the same as described for Alternative A.

- **Northern Spotted Owl.** Impacts would be similar to those described for Alternative A, with a slight increase in the extent of both adverse and beneficial impacts as the amount of land that could be treated under Alternative B is about twice that of Alternative A. Mitigations would be the same as described for Alternative A.

- **Salt Marsh Harvest Mouse.** Under Alternative B, little to none of the acreage to be treated is expected to include or adjoin salt marsh harvest mouse habitat at Rodeo Lagoon. Impacts and mitigations would be the same as described for Alternative A.

Pile Burning. Pile burning under Alternative B would affect special status wildlife species as follows.

- **San Bruno Elfin Butterfly.** Impacts and mitigations would be the same as described for Alternative A.

- **Mission Blue Butterfly.** Impacts and mitigations would be the same as described for Alternative A.

- **Coho Salmon and Steelhead.** Impacts and mitigations would be the same as described for Alternative A.

- **California Red-Legged Frog.** Impacts and mitigations would be the same as described for Alternative A.

- **San Francisco Garter Snake.** While the acreage subject to mechanical fuel reduction and pile burning under Alternative B would be double that under Alternative A, most of it would occur in Marin County. The objectives of fuel reduction and pile burning suggest that San Francisco garter snake habitat is unlikely to be targeted for these activities. Any adverse impacts would be minor and short-term, while some long-term beneficial impacts may result from concurrent restoration of native habitats. Mitigations would be the same as described for Alternative A.

- **Marbled Murrelet.** Potential marbled murrelet habitat only occurs within Muir Woods. Treatment of Muir Woods would be the same under all alternatives and is addressed in the "Actions Common to All Alternatives" section above.

- **California Brown Pelican.** Pile burning would not be conducted within California brown pelican roosting habitat. Effects from drifting smoke would be negligible.

- **Northern Spotted Owl.** Impacts would be similar to those of Alternative A, with a slight increase in the extent of adverse impacts from disturbance and drifting smoke, since the amount of pile burning under Alternative B could be double the amount under Alternative A. Impacts and mitigations would be the same as described for Alternative A.

Prescribed Burning. Prescribed burning under Alternative B would affect special status wildlife species as follows.

- **San Bruno Elfin Butterfly.** No prescribed burning is planned in San Mateo County under Alternative B, so the San Bruno elfin butterfly would not be affected.

- **Mission Blue Butterfly.** Prescribed fire would not be used in Wildland-Urban Interface Initiative areas. No prescribed burning would occur in San Mateo County. Impacts and mitigations would be the same as described for Alternative A.

- **Tidewater Goby.** Only a very small proportion of acres subject to prescribed burning would be close to Rodeo Lagoon. Impacts and mitigations would be the same as described for Alternative A.

- **Coho Salmon and Steelhead.** Prescribed fire would not be used in Wildland-Urban Interface Initiative areas. No prescribed burning would occur in San Mateo County. Impacts and mitigations would be the same as described for Alternative A.

- **California Red-Legged Frog.** Prescribed fire would not be used in Wildland-Urban Interface Initiative areas. No prescribed burning would occur in San Mateo County. Impacts and mitigations would be the same as described for Alternative A.

- **San Francisco Garter Snake.** No prescribed burning is planned in San Mateo County under Alternative B, so the San Francisco garter snake would not be affected.

- **Marbled Murrelet.** Potential marbled murrelet habitat only occurs within Muir Woods. Treatment of Muir Woods would be the same under all alternatives and is addressed in the "Actions Common to All Alternatives" section above.

- **Western Snowy Plover.** The western snowy plover would not be affected by research burns in San Francisco.

- **California Brown Pelican.** No prescribed fire is planned to occur within areas used by brown pelicans for roosting at Rodeo Lagoon or Bolinas Lagoon. Negligible impacts on roosting birds may occur as a result of drifting smoke.

- **Northern Spotted Owl.** The majority of prescribed burning in spotted owl habitat would be within Muir Woods National Monument. Impacts and mitigations would be the same as described for Alternative A.

- **Salt Marsh Harvest Mouse.** Only a very small proportion of acres subject to prescribed burning would be close to Rodeo Lagoon. Impacts and mitigations would be the same as described for Alternative A.

Research. Alternative B would include an element of research into the effects of fire on natural resources only in the Muir Woods and Park Interior FMUs in Marin County. Research under this alternative would lead to better management of native plant communities through the use of fire as a tool to move toward desired conditions. Overall, research would have a beneficial impact, as the results could inform future decision making related to management of habitat for threatened and endangered wildlife species. Since these research burns would be synonymous with the prescribed burning described above, the same mitigations would be applied to protect threatened and endangered wildlife, and the possible adverse impacts would be the same. Overall impacts on threatened and endangered wildlife would be beneficial, long-term, and minor to moderate.

Cumulative Impacts. Cumulative effects on special status wildlife species resulting from other actions combined with Alternative B would be the same as described for Alternative A.

Conclusion. In summary, Alternative B would have the following effects on special status wildlife species.

- **San Bruno Elfin Butterfly.** Impacts would be similar to those for Alternative A, with the potential for a slight increase in the extent of impacts as the amount of land that could be treated mechanically under Alternative B is about twice as much as in Alternative A. With mitigation, adverse impacts would still be minor and short-term. Beneficial impacts would be the same as in Alternative A.

- **Mission Blue Butterfly.** Adverse impacts from mechanical fuel reduction in Alternative B would be slightly greater than in Alternative A since more than twice the acreage would be treated mechanically, but still minor and short-term following mitigation. The long-term beneficial impacts from potential expansion of mission blue butterfly habitat would be greater in Alternative B. Impacts from prescribed burning, pile burning, and fire research would be the same as in Alternative A.

- **Tidewater Goby.** Impacts would be the same as described for Alternative A.

- **Coho Salmon and Steelhead.** Impacts would be similar to those for Alternative A, with a slight increase in the extent of impacts as the amount of land that could be treated mechanically under Alternative B is more than twice the amount in Alternative A. With mitigation, adverse impacts from site disturbance and vegetation removal would still be minor and short-term, with potential for greater long-term beneficial impacts through restoration of riparian habitat by removal of nonnative vegetation.

- **California Red-Legged Frog.** Impacts would be the same as described for Alternative A.

- **San Francisco Garter Snake.** Even though twice as many acres may be treated mechanically in San Mateo County, impacts associated with mechanical fuel reduction and pile burning would be the same as in Alternative A since San Francisco garter snake habitat is unlikely to be targeted for these activities. Prescribed burning and research burns would not occur in San Mateo County under Alternative B, so there would be no associated impacts.

- **Marbled Murrelet.** Impacts on marbled murrelets are addressed in the "Actions Common to All Alternatives" section, since the only potential nesting habitat occurs within Muir Woods National Monument.

- **Western Snowy Plover.** Impacts would be the same as described for Alternative A.

- **California Brown Pelican.** Impacts would be the same as described for Alternative A.

- **Northern Spotted Owl.** Impacts from mechanical fuel reduction and pile burning would be similar to those described for Alternative A following mitigation, with a slight increase in the extent of both adverse and beneficial impacts, as the amount of land that could be treated mechanically under Alternative B is about twice as much as in Alternative A. Impacts associated with prescribed burning and fire research would be the same as in Alternative A.

- **Salt Marsh Harvest Mouse.** Impacts would be the same as described for Alternative A.

Impairment. No impairment of any threatened and endangered species would occur under Alternative B.

Alternative C

Mechanical Fuel Reduction. Under Alternative C, mechanical fuel reduction would affect special status wildlife species as follows.

- **San Bruno Elfin Butterfly.** Impacts and mitigations would be the same as described for Alternative A.

- **Mission Blue Butterfly.** Impacts would be similar to those of Alternative A, though greater in extent, with a moderate increase in the amount of land that could be treated compared to Alternative A. Adverse impacts from site disturbance and vegetation removal would still be minor and short-term because most mechanical fuel reduction would not occur in areas mapped as existing or potential mission blue butterfly habitat. Alternative C has the potential to result in minor-to-moderate long-term beneficial impacts through potential expansion of mission blue butterfly habitat in Marin and San Mateo counties. Mitigations would be the same as described for Alternative A.

- **Tidewater Goby.** Little to no acres treated are expected to include or adjoin tidewater goby habitat at Rodeo Lagoon. Impacts and mitigations would be the same as described for Alternative A.

- **Coho Salmon and Steelhead.** Impacts would be similar to those of Alternative A, though greater in extent, with a moderate increase in the amount of land that could be treated under Alternative C. Adverse impacts from site disturbance and vegetation removal would still be minor and short-term, since only a small proportion of those acres would include or adjoin salmonid habitat. Alternative C has the potential for the greatest long-term beneficial impacts through restoration of riparian habitat affected by nonnative vegetation. Impacts and mitigations would be the same as described for Alternative A.

- **California Red-Legged Frog.** The majority of mechanical fuel reduction activities would be conducted outside areas typically considered as either breeding or non-breeding red-legged frog habitat (e.g., emergent marshes and stream riparian corridors). Impacts and mitigations would be the same as described for Alternative A.

- **San Francisco Garter Snake.** Impacts and mitigations would be the same as described for Alternatives A.

- **Marbled Murrelet.** Potential marbled murrelet habitat only occurs within Muir Woods. Treatment of Muir Woods FMU would be the same under all alternatives and is addressed in the "Actions Common to All Alternatives" section above.

- **California Brown Pelican.** The only actions potentially associated with mechanical fuel reduction that may adversely affect California brown pelican roosting areas at Rodeo or Bolinas Lagoons would be use of helicopters for tree removal. Impacts and mitigations would be the same as described for Alternative A.

- **Northern Spotted Owl.** Impacts would be similar to those of Alternative A, with a slight increase in the extent of both adverse (short-term, minor) and beneficial impacts (long-term, minor) as the amount of land that could be treated under Alternative C is greater than under Alternative A. Mitigations would be the same as described for Alternative A.

- **Salt Marsh Harvest Mouse.** Few to none of the acres to be treated under this alternative are expected to be in or adjacent to salt marsh harvest mouse habitat at Rodeo Lagoon. Impacts and mitigations would be the same as described for Alternative A.

Pile Burning. Pile burning under Alternative C would affect special status wildlife species as follows.

- **San Bruno Elfin Butterfly.** Impacts and mitigations would be the same as described for Alternative A.

- **Mission Blue Butterfly.** Impacts and mitigations would be the same as described for Alternative A.

- **Coho Salmon and Steelhead.** Although significantly more areas would be treated mechanically and subject to pile burning under Alternative C compared to Alternative A, riparian habitat

mitigations would adequately protect salmonid habitat. Impacts and mitigations would be the same as described for Alternative A.

- **California Red-Legged Frog.** Although significantly more areas would be treated mechanically and subject to pile burning under Alternative C compared to Alternative A, wetland habitat mitigations would adequately protect red-legged frog habitat. Impacts and mitigations would be the same as described for Alternative A.

- **San Francisco Garter Snake.** The acreage in San Mateo County that would be subject to mechanical treatment and subsequent pile burning annually under Alternative C would be the same as under Alternative A. Impacts and mitigations would be the same as described for Alternative A.

- **Marbled Murrelet.** Potential marbled murrelet habitat only occurs within Muir Woods. Treatment of Muir Woods FMU would be the same under all alternatives and is addressed in the "Actions Common to All Alternatives" section above.

- **California Brown Pelican.** Pile burning would not be conducted within California brown pelican roosting habitat. Effects from drifting smoke would be negligible.

- **Northern Spotted Owl.** Impacts would be similar to those of Alternative A, with a slight increase in the extent of short-term, minor adverse impacts from disturbance and drifting smoke as the amount of pile burning under Alternative C would be greater than the amount under Alternative A. Mitigations would be the same as described for Alternative A.

Prescribed Burning. Prescribed burning under Alternative C would affect special status wildlife species as follows.

- **San Bruno Elfin Butterfly.** Alternative C would allow prescribed burning on almost three times the acreage called for in Alternative A. However, prescribed burns would not occur directly within existing or potential San Bruno elfin butterfly habitat. Impacts and mitigations would be the same as described for Alternative A.

- **Mission Blue Butterfly.** Only research burns would be conducted in existing mission blue butterfly habitat (habitat supporting host plants). Adverse impacts would be the same as described for Alternative A, while long-term, moderate, beneficial impacts may potentially be much greater due to use of fire to control nonnative plants and to manage adjacent grassland/scrub habitat to improve and restore habitat for the mission blue butterfly. Mitigations would be the same as described for Alternative A.

- **Tidewater Goby.** Only a very small proportion of the acres proposed for treatment in Alternative C would be close to Rodeo Lagoon. Impacts and mitigations would be the same as described for Alternative A.

- **Coho Salmon and Steelhead.** Impacts would be similar to those described for Alternative A, with a slight increase in the extent of adverse (short-term, minor) impacts, and an increase in beneficial impacts (long-term, moderate) as the overall amount of land that could be treated under Alternative C by prescribed burning is almost three times that of Alternative A. However, it is expected that only a small proportion of the acres treated would include or adjoin salmonid habitat. Mitigations would be the same as described for Alternative A.

- **California Red-Legged Frog.** Impacts and mitigations would be the same as described for Alternative A.

- **San Francisco Garter Snake.** It is expected that only a small proportion of the acres treated would include or adjoin potential San Francisco garter snake habitat. Impacts and mitigations would be the same as described for Alternative A.

- **Marbled Murrelet.** Potential marbled murrelet habitat only occurs within Muir Woods. Treatment of Muir Woods FMU would be the same under all alternatives and is addressed in the "Actions Common to All Alternatives" section above. Impacts would be negligible.

- **Western Snowy Plover.** No prescribed burning, aside from research burns associated with federally listed plant species, is planned in San Francisco County under Alternative C, so the western snowy plover would not be affected.

- **California Brown Pelican.** No prescribed fire is planned to occur within areas used by brown pelicans for roosting at Rodeo Lagoon or Bolinas Lagoon. Negligible impacts on roosting birds may occur as a result of drifting smoke.

- **Northern Spotted Owl.** Impacts would be similar to those of Alternative A, with a slight increase in the extent of both adverse (short-term, minor) and beneficial impacts (long-term, minor) as the overall amount of land that could be treated under Alternative C is nearly three times that of Alternative A. However, the majority of prescribed burning in spotted owl habitat would be within Muir Woods National Monument. Mitigations would be the same as described for Alternative A, and the impacts would be the same.

- **Salt Marsh Harvest Mouse.** Only a very small proportion of those acres that would be treated by prescribed burning would be close to potential salt marsh harvest mouse habitat at Rodeo or Bolinas Lagoons. Impacts and mitigations would be the same as described for Alternative A.

Research. Alternative C would include an element of research into the effects of fire on natural resources in both Marin and San Mateo counties in both the WUI and Park Interior FMUs. Research under this alternative would lead to better management of native plant communities through the use of fire as a tool to move toward desired conditions. Overall, research would have a beneficial impact, as the results would inform future decision making related to management of habitat for threatened and endangered wildlife species. Since these research burns would be synonymous with the prescribed burning described above, the same mitigations would be applied to protect threatened and endangered wildlife, and the possible

adverse impacts would be the same. Overall impacts on threatened and endangered wildlife would be long-term, beneficial, and minor to moderate.

Cumulative Impact. Cumulative impacts would be the same as described for Alternative A.

Conclusion. In summary, Alternative C would have the following effects on special status wildlife species.

- **San Bruno Elfin Butterfly.** Impacts associated with fire management actions would be the same as described for Alternative A.

- **Mission Blue Butterfly.** Impacts associated with mechanical fuel reduction and pile burning would be similar to those described for Alternative A, though greater in extent, with a moderate increase in the amount of lands that could be treated under Alternative C. Adverse impacts from site disturbance and vegetation removal would still be minor and short-term. Alternative C has the greatest potential to result in minor-to-moderate long-term beneficial impacts, since it incorporates the most extensive use of mechanical treatment, prescribed fire, and research burns that could be used to improve and expand mission blue butterfly habitat.

- **Tidewater Goby.** Impacts would be the same as under Alternative A.

- **Coho Salmon and Steelhead.** Overall impacts of mechanical fuel treatment, pile burning, use of prescribed fire, and fire research would be similar to those for Alternative A, with a slight increase in the extent of both adverse (short-term, minor) and beneficial impacts (long-term, moderate), as the amount of land that could be treated and habitat restored under Alternative C is greater than under Alternative A.

- **California Red-Legged Frog.** Impacts would be the same as under Alternative A.

- **San Francisco Garter Snake.** Impacts would be the same as under Alternative A.

- **Marbled Murrelet.** Impacts on marbled murrelets are addressed in the “Actions Common to All Alternatives” section above, since the only potential nesting habitat occurs within Muir Woods National Monument.

- **Western Snowy Plover.** Impacts would be the same as under Alternative A.

- **California Brown Pelican.** Impacts would be the same as under Alternative A.

- **Northern Spotted Owl.** Impacts of mechanical fuel reduction and pile burning would be similar to those for Alternative A, with a moderate increase in the extent of both adverse (short-term, minor) and beneficial (long-term, moderate) impacts as the amount of land that could be treated under Alternative C is greater than under Alternative A. Impacts of prescribed fire would be similar to those for Alternative A, with an increase in the extent of both adverse (short-term,

minor) and beneficial (long-term, minor) impacts as the acreage subject to burning under Alternative C is nearly three times that under Alternative A.

- **Salt Marsh Harvest Mouse.** Impacts would be the same as under Alternative A.

Impairment. No impairment of any threatened and endangered species would occur under Alternative C.

Impacts on the Social Environment

Impacts on Cultural Resources

Analysis

The NPS recognizes five categories of cultural resources for management purposes.

Archeological resources are the remains of past human activity and records documenting the scientific analysis of these remains. They are typically buried but may extend aboveground; they are commonly associated with prehistoric peoples but are also commonly products of more contemporary society. They shed light on often otherwise unrecorded questions, such as social organization, and have helped researchers to understand the spread of ideas over time and the development of settlement from place to place.

Cultural landscapes are environmental settings that human beings have created in the world that reveal the fundamental ties between people and the land and reflect the human need to grow food, give form to settlements, meet a need for recreation or work, or bury the dead.

Structures are material assemblies that extend the limits of human capabilities, such as buildings to keep people warm and dry. Bridges to cross barriers, ships and trucks to carry goods over long distances, fortifications for protection, and statues and monuments to commemorate human achievement all are types of structures.

Ethnographic resources represent basic expressions of human culture and contribute to the continuity of tangible and intangible cultural systems, such as traditional arts, native languages, religious beliefs, and subsistence activities. In parks, they include special places in the natural world, structures with historic associations, and natural materials.

Museum objects are tangible manifestations and records of behavior and ideas that span the breadth of human experience and the depth of natural history. They are evidence of intellectual and technical development, of scientific observation, of personal expression and curiosity, and of common enterprise and daily habits. They are invaluable and irreplaceable samples of the world through time and place and of the multitude of life therein.

Actions Common to All Alternatives

Wildland-Urban Interface Initiative

In 2001, the NPS began implementing provisions of the federal Wildland-Urban Interface Initiative program. This program was designed to facilitate cooperative ventures with park neighbors – including

other federal agencies, states, counties, private landowners, and local fire agencies – to reduce the potential for wildland fire to burn across federal lands and neighboring properties.

The emphasis of this program at GGNRA as evaluated here, is to reduce the density of hazardous fuels that create a risk to lives or property on parklands. This program would continue under all alternatives. Effects of this program are beneficial, long-term, and major, since avoidance of catastrophic fire in areas along the park boundary clearly lessens the risk to park cultural resources.

Defensible Space/Vegetation Clearing Around Structures

The protection of all buildings from wildfire within GGNRA would continue under all alternatives. NPS staff or private contractors would continue to clear vegetation around all park structures. Individual structures would be assessed to determine the appropriate vegetation treatment based on fuel type and slope, building construction type, and potential sources of ignition. The defensible space required usually ranges from 30 to 50 feet around each structure. In some cases, a larger cleared area may be required to protect the structure from potential fire hazard due to prevailing winds or the presence of drainages or swales close to the structure. Fuel type and fuel loading are also factors considered in determining these types of projects. Large trees are pruned or removed if the tree poses a threat, grasses are cut to stubble, and smaller trees are pruned or removed based on an individual assessment; pruning and removal actions must be in conformance with approved cultural landscape preservation plans and bird nesting season restrictions. If the landscape is potentially historic, then cultural resources staff would be consulted and the project would proceed to consultation under Section 106 of the NHPA, with the goal of minimizing adverse effects. The effect of this program on park cultural resources is beneficial, short-term, and major.

Roadside Fuel Reduction

The park routinely clears vegetation and debris from selected dirt and paved roads that provide routes for emergency evacuation and access for fire suppression activities or conducting prescribed burns, or that serve as control lines for prescribed fire projects. An assessment of road conditions is typically performed in early spring, and then a work plan is developed and priorities for vegetation clearing are set. Designated fire roads would continue to be maintained to allow for safe and efficient access and egress by emergency vehicles.

Maintenance standards for existing fire roads would be developed by park staff and would include guidance on such actions as grading of all surfaces when necessary, removal of vegetation to a specified width based on fuel type and slope, and mowing and cutting techniques. For road clearing, trees along the sides of the roadways would be limbed, trees less than 4 inches in diameter removed, downed trees in or near the roads cleared, and grass growing up within the roads cut or mowed. Tools used for these tasks would include weed whackers, chain saws, pole saws, and a chipper towed onsite. Debris can be cut up and broadcast in the immediate area, piled and burned, or chipped and hauled offsite. Regrading would occur where rills and gullies have formed. Where necessary, regrading should follow standard local practices established by the park. This would include outsloping of roads to prevent rill and gully erosion.

The park will evaluate, on an ongoing basis, the condition of fire roads for direct and safe access conditions. As a result of this evaluation, unnecessary fire roads may be eliminated, and the sites restored

to address erosion problems. In some cases, existing roads may be reconfigured or rerouted to address erosion and/or maintenance concerns.

In all cases, cultural resource staff would be consulted to identify the existence of historic roads, trails, and other historic properties within the project area. If cultural resources are found to exist, then the project will proceed to consultation under Section 106, with the goal of minimizing adverse impact.

The effect of this program, with proper mitigations applied, would be beneficial, long-term, and minor.

Suppression

Due to often-extreme fire behavior, the direct effects of wildfires on cultural resources can be substantial and can include adverse damage. In this regard, the pre-action mitigation measures described in Chapter 2 will measurably contribute to minimizing adverse impacts from the operational and indirect effects of wildland fire suppression activities.

Much of the park has not been fully inventoried; cultural resources inventories and surveys to date have concentrated in areas with known, or predicted sensitivity for, cultural resources. Wildfires may thus affect cultural resources in ways that cannot be fully anticipated, but would, in the worst-case scenario, be adverse, long-term, and major. It would logically follow that suppressing such fires would minimize the potential adverse effects.

Information regarding direct effects would, in most cases, be obtained during the post-burn phase, and involve evaluating those effects on resources for which no pre-burn condition data were available. It is possible that an uncontrolled large wildfire could destroy or remove all information from cultural resources or have a short- or long-term effect on the integrity of cultural landscapes.

Operational effects associated with wildfire suppression can often be adverse, major, and permanent. The acts of constructing fire lines either by hand or with a dozer, using helispots, creating staging areas, mopping up, and other ground-disturbing processes can have major adverse permanent impacts on cultural resources, particularly those that are on the ground or buried. Even with use of MIST (see Appendix G), the placement of fire lines and related phenomena can be quite unsystematic when compared to planned fire management actions. Although the use of heavy equipment for fire suppression is prohibited unless authorized by the park superintendent, it is a standard tool for agencies charged with fire management on adjacent lands and would almost certainly be employed in cases where life or property was at risk.

Large numbers of personnel, from varied backgrounds, are present at any fire. Crews are often spread across a vast area. Cultural resource looting and vandalism can potentially occur during wildfire events. These adverse impacts would be minor at known sites where most archeological resources have been recorded and surface artifacts removed, but potentially more serious at previously unknown and unrecorded sites. NPS resource advisors would be onsite quickly after a burn to ensure that looting and vandalism do not occur.

During suppression activities, some cultural landscape elements may be altered. However, many would be altered only temporarily and could be restored, and most suppression activities would not alter a significant number of characteristics of a particular cultural landscape. Therefore, suppression activities would have short-term, moderate, adverse effects on cultural landscapes because a small percentage of the historic landscapes would likely be lost and the effect should not last more than 10 years.

In summary, uncontrolled wildfire could have permanent, adverse, major effects on historic buildings due to loss during the wildfire. Archeological sites may experience permanent, adverse, major effects from suppression efforts because heavy equipment such as a tractor and blade may inadvertently affect an archeological or historical site. Because of the regenerative nature of vegetation, the effects on cultural landscapes may only be medium-term, moderate, and adverse because a small percentage of the historic landscapes would likely be lost and the effect should not last more than 10 years.

Treatment of Muir Woods FMU

Preservation of the pristine character of Muir Woods National Monument is a management priority (1993 FMP). Many species contribute to this ecosystem, and the variety of communities in Muir Woods National Monument calls for a variety of prescription parameters. A fire management project strategy for Muir Woods National Monument included in the 1993 FMP includes a mix of prescribed burning, mechanical fuel reduction, and understory thinning projects. Prescribed burning would be used to reduce fuel loading and to reintroduce fire into the diverse plant communities in the monument.

Established trails, roads, and natural features would be used as much as possible as fire lines. Burns would be from 0.5 to 50 acres. Implementation of this strategy would continue under all alternatives. This strategy of both fuel reduction and resource enhancement in coast redwood forests has proven effective throughout the range of redwood forests, and would continue within Muir Woods National Monument. A public awareness program would be necessary to carry out any prescribed burning; burning in Muir Woods National Monument can be a sensitive issue and requires staff to inform and educate the public, other interested parties, and neighboring agencies about prescribed burning in that area.

Muir Woods National Monument is presently the subject of an historic resource study, and it has potential for designation as a National Historic Landmark for its park design and its place in the national conservation movement. In this regard, the fire management activities at Muir Woods National Monument will be developed with the participation of park cultural resource staff, and the public awareness program will include information about Muir Woods National Monument as an historic resource.

The effect of this fire management strategy, with application of specific mitigations and developed in conjunction with Section 106 consultation, is beneficial, short-term, and moderate.

Treatment of San Francisco County Project Area

The primary actions for the parklands within San Francisco County would be maintenance of defensible space around buildings adjacent to wildland fuels and limited mechanical fuels removal elsewhere. Impacts of these actions on cultural resources, with standard mitigations applied, would be beneficial, short-term, and moderate.

Public Information and Fire Education Programs

Impacts associated with fire information and educational efforts would largely be beneficial, although highly dependent on the nature of the fire management action. Pre-planned events such as prescribed fires and mechanical treatment provide the opportunity to inform people about cultural resources and to demonstrate the effectiveness of cultural resources compliance to local American Indian communities and the interested public. During unplanned events, such as wildfires, time for effective communication is often more limited and can be more controversial since resources are often damaged.

Fire Cache

The construction of a centralized fire cache in GGNRA would have no influence on the direct effects of fire management actions on cultural resources. However, relocating fire management personnel to a more centralized location would allow for faster response time to cultural resources in the event of wildfires.

Operational effects associated with the construction of the new fire cache are unlikely to occur.

No adverse or beneficial indirect effects are anticipated with the construction of the new fire cache.

If an historic structure is selected as the location of the fire cache, the 1992 Golden Gate Programmatic Agreement with the State Historic Preservation Officer (SHPO) can be used as the vehicle for consultation that can ensure that there is no adverse effect as a result of the undertaking.

Fire Effects Monitoring

No adverse or beneficial effects on cultural resources are anticipated from the continued implementation of the fire effects monitoring program. All historic structures and archeological sites are excluded during FMH plot location and selection and treated areas would be located away from any known sites.

Mitigation Measures

Mitigation measures are actions that reduce the impact of the planned activities on a particular resource. In this case, all of the measures listed in Chapter 2, Section 2.7, Mitigation Measures, would be employed, as appropriate, at GGNRA, and would be identified in programmatic agreements among state and federal cultural resource protection agencies and the NPS. They are divided into measures that would be taken before project implementation (prescribed fire or mechanical thinning, suppression of unplanned ignitions), during these actions, and after implementation. Because appropriate mitigations are mandatory, the alternatives are analyzed assuming each would be put into place as warranted during review of individual fire management activities under a programmatic agreement or under 36 CFR 800. The effects on cultural resources would be considered during all fire management planning efforts. Section 106 review of individual projects is performed according to the Advisory Council's regulations for implementing the National Historic Preservation Act, 36 CFR 800.

Alternative A

Analysis

The 1993 GGNRA FMP is primarily a tool for prescription and use of fire as an integral factor influencing park ecosystems. Although the goals of the plan address the need to protect both natural and

cultural resources from unacceptable impacts attributable to wildland fire and fire management activities, the proactive programs consist entirely of activities designed to enhance natural ecosystems. Cultural resources are addressed in the plan primarily in terms of protection of archeological resources from the direct and indirect effects of prescribed burns. The existence of numerous historic structures within the park is acknowledged, and their protection from the adverse effects of fire management activities is implied. There is no substantive mention of other cultural resources in the plan, and the assumption is that all effects of fire management activities are adverse ones. Thus no opportunities are raised for the use of such activities for the preservation or enhancement of cultural landscapes, ethnographic resources, or archeological sites.

Direct effects of fire management actions on cultural resources could well be adverse, especially during extreme fire behavior, such as the suppression of unplanned wildfires. Such actions are often carried out with relatively little pre-planning and without consultation or supervision by a cultural resource specialist. Risk of adverse effect may be particularly high for archeological resources, historic structures, and potential museum objects. Direct effects of wildfire may also be likely to adversely affect ethnographic resources and cultural landscapes. The degree to which heating plays a role is complex and not fully understood, but in general, the longer a resource is exposed to heat and the higher the temperature, the greater the likelihood of damage. Fire can result in the complete elimination of an artifact or feature through consumption, or can alter attributes of an artifact or feature (e.g., obsidian hydration rinds, residues on pottery, bone burning) such that important research is hindered, or traditional values (e.g., Native American spiritual sites) are affected.

Running surface and crown fires occur primarily during wildfires, whereas ground or creeping active surface fires are usually associated with prescribed burns. Very generally, cultural resources located at or above the ground surface (e.g., lithic scatter, masonry or wood surfaces of historic structures, landmark trees) are most vulnerable to direct fire effects during crown and active surface fires, while ground and creeping surface fires threaten resources found just below the ground surface (e.g., shell middens, refuse deposits, foundations). Because of this, the chances of adversely affecting a high percentage of cultural resources found exclusively on or just beneath the ground surface are often as great as are the chances of affecting the aboveground resources. This is significant because cultural resources generally considered to have high data potential, such as Native American middens, may actually have a far lower percentage of artifact classes or attributes exposed to direct fire effects than a lithic scatter, often considered to have low data potential that is restricted to the ground surface. While it is the midden that would probably receive the greatest amount of attention in regard to a planned or unplanned fire management action, it is the lithic scatter that has the potential to undergo the greatest intensity of impact.

Fire management activities, especially carefully applied prescribed fire and mechanical fuel reduction treatments, can also be highly beneficial, however, and can be used to stabilize, preserve, maintain, and restore cultural resources. For example, mechanical thinning can effectively remove hazardous fuels from cultural resources and their vicinity, as well as restore, enhance, or maintain ethnographic resources and cultural landscapes, in cases where the risk of direct effect from the application of fire is too high. Historic field patterns may be restored in pastoral ranching landscapes where former grassland is being succeeded by scrub. In regard to ethnographic resources, some plants important for basketmaking benefit

from the careful application of fire. In addition, the removal of dense ground cover may lead to the revelation of previously unknown archeological sites.

Direct effects on cultural resources are also likely to occur as a result of fire management operations associated with wildfires, prescribed burns, and mechanical thinning. These operational effects on cultural resources have been quantified in only relatively few cases. However, several generalizations can be made, as follows.

Impacts resulting from the operation of heavy equipment on and close to cultural resources will correlate directly with the nature and extent of the disturbance, nature of local sediments, and nature and extent of cultural resources. Heavy equipment, aviation landing areas, large camps, and staging areas in previously undisturbed locations would not be used except to support wildfire suppression, since their effect is overwhelmingly likely to be adverse.

With the exception of operations that result in more intense fire behavior (e.g., slash piles, firing techniques), fire management operations will generally produce impacts that are less intense than the direct impacts resulting from wildland fire itself. Existing fire roads would usually be used; any new firebreaks could be carefully located. An obsidian projectile point displaced by construction of a fire line would probably retain its hydration rind, morphology, and other attributes, if not its provenience and stratigraphy. However, this does assume the application of operational techniques in a manner that is sensitive to cultural resources. Otherwise, loss of significant historic characteristics, such as boundary fence lines or signature plantings, or the encouragement of erosion, could be serious. Except in rare situations, operational effects are likely to be most pronounced when they involve cultural resources found on and near the ground surface.

Indirect effects may be delayed and incremental, and are related most strongly to the intensity of the fire management effort, although context and the nature of the resource play important roles. For example, intense fire behavior and major suppression efforts associated with wildfires would often mean that indirect effects, such as loss through erosion, would occur relatively quickly and to a larger degree than following a smaller prescribed burn or mechanical thinning. Over time, these smaller actions can have adverse consequences of similar magnitude to wildfire suppression. The indirect effects of fire management actions related to high-intensity wildfires would be generally adverse.

As noted in Chapter 3, cultural resource surveys at GGNRA are not 100-percent complete. The areas that are less likely to have been surveyed are newly acquired areas, such as in San Mateo County; areas where predictive modeling indicates less sensitivity; and areas that are difficult to reach because of rugged topography, thick vegetation, or both. Because these areas have not been surveyed, they are vulnerable to the loss of resources and information during what could be quite intense burns. Settlement in the area has by and large taken place where topography is less steep, along fresh and saltwater sources, and where vegetation is not dense, and it is these areas where cultural resource data are more likely to have been recorded. The combination of less dense vegetation and more intense surveys in these areas means that these resources are not as likely to suffer more than minor or moderate impacts, even in a wildland fire.

Mechanical Treatment

Under this alternative, 100 acres per year throughout the park would be treated by mechanical means.

Operational effects present the greatest concern in regard to the potential impacts of mechanical treatment. Ground disturbance could result in substantial impacts on cultural resources. Mechanical treatments offer the benefit of pre-planning, however, in that the location(s) of ground disturbance can be specifically delineated and known cultural resources avoided. In the event that an area cannot be adequately surveyed due to thick vegetation, a cultural resource specialist could monitor the mechanical treatment for cultural resources that become exposed. Likewise, less intensive mechanical treatments can be employed in highly sensitive areas. While looting by fuels crews cannot be discounted, these effects could be minimized through a combination of education and avoiding known resources. Together, these activities would prevent impacts on cultural resources from mechanical thinning from becoming more than short-term and minor.

A variety of indirect effects could arise as a result of mechanical treatments. The use of heavy equipment could result in soil compaction and potential soil erosion on and near cultural resources. The act of thinning vegetation on or near cultural resources might damage them or leave them vulnerable to looting. Again, however, the ability to perform pre-treatment surveys means that sensitive resources can be identified, mitigations set in place, equipment excluded from or near cultural resources, and vegetation strategically left in place to discourage looting. Mechanical treatments also offer the potential short-term moderate benefit of reducing fuel loads in proximity to cultural resources. They would also offer long-term moderate benefits by providing the opportunity for survey or inventory in previously unrecorded areas, and restoring and/or maintaining historical scenes associated with structures and cultural landscapes, especially in situations where it is not desirable or possible to accomplish these tasks with the direct application of fire. The cumulative effect of mechanical treatments would be moderate, long-term, and beneficial.

Pile Burning

Prescribed burning of vegetation piles would be undertaken as a follow-up to mechanical fuels treatment activities. Fuel loads in these piles would be substantial and would tend to burn at very high intensities. Pile locations would be sited to minimize impacts from intensive soils heating, and pile sizes would be limited to 4 cubic yards. However, since the ability to pre-plan is inherent in the activity of pile burning, input from cultural resource specialists, surveying and testing as appropriate, and proper location of piles would ensure that piles are not created on or near cultural resources, and any effects would thus be no more than minor and short-term, and not adverse.

Prescribed Burning

Under this alternative, a maximum of 110 acres per year would be burned using prescribed fire. As already described in the beginning of this section, prescribed burning may offer benefits to cultural resources. For example, areas to be burned would be surveyed and staff could locate and evaluate the significance of cultural resources they would not otherwise have an opportunity to assess. The ability to conduct pre-burn inventories also allows the park to quantitatively and spatially document fuel conditions and require mechanical treatment of particularly dense vegetation to avoid damage to important cultural

sites. If this is not possible, the information about fuel conditions would be used to direct post-burn surveys and more meaningfully assess damage to cultural resources that could not be mitigated prior to the burn. These benefits are expected to be minor because it cannot be assumed that significant unknown archeological or historic resources would be found in these areas. In addition, prescribed burns could be conducted in areas to achieve cultural landscape objectives, offering long-term and short-term moderate benefits if a landscape is restored. The benefit is moderate because prescribed burning could provide a measured change in the significant characteristic of the landscape. For example, prescribed burning could restore grasslands and open up an historic viewshed (part of a cultural landscape) that has been lost because of vegetation growth.

Prescribed burns could also be used to improve conditions at, or safety of, a cultural resource, and in particular historic buildings. For example it is possible, through varied timing or operational procedures (e.g., heading or backing fire) to achieve lower or higher fire intensities. A low-intensity fire might be used on or immediately adjacent to a particular cultural resource such as an historic structure, while a high-intensity fire could significantly reduce hazardous fuels surrounding the resource. Prescribed burns are implemented at times when the likelihood of escape is low, thereby minimizing potential effects on those cultural resources close to a burn unit. Reducing fuel loads from around historic structures could offer short-term moderate benefits for cultural resources.

As noted above, a standard mitigation measure for prescribed burns in the park is the participation of a cultural resource specialist when there is a possibility of cultural resources being affected. The cultural resource specialist would provide input into the planning of the burn, monitor fire behavior and the effectiveness of mitigation measures during the burn, and assess the aftermath for future reference. The specialist would also be available in case of fire escape to help mitigate or minimize potential adverse effects of suppression.

A cultural resource specialist may also monitor preparation activities, such as fire line construction. The specialist would survey the site where these activities are planned and collaborate on the best location for them, monitor construction to ensure minimal damage, and brief fire personnel on the proper protocol in and around cultural resources. The presence of a specialist is likely to keep impacts on archeological sites from these activities low, so they would be no more than minor and short-term.

Pre-burning planning allows the cultural resources specialist to account for potential indirect effects. For example, if high tree mortality is a concern following the burn, efforts could be made to reduce the number of trees in proximity to a cultural resource. Some indirect effects such as erosion are exacerbated by intense fire behavior, the type that is unlikely to occur over large areas during prescribed burns.

The cumulative effects of prescribed burning with proper mitigations would be moderate, beneficial, and long-term.

Cumulative Impacts

Based on an analysis of the list of projects in Appendix C, the cumulative impacts of all the projects listed would not change the potential intensity or duration of the individual impacts on cultural resources. Because of the underlying philosophy of the 1993 FMP, the selection of the projects is primarily

motivated by the goal of restoring the benefits of fire to natural ecosystems. Nevertheless, many of the projects listed also have beneficial effects on cultural resources. However, a large-scale, high-intensity, uncontrolled fire such as the 1995 Vision Fire at Point Reyes National Seashore would dramatically increase all impacts on cultural resources (see impacts above). Extremely high fire temperatures can be expected, with the implication that even the most durable cultural resources would be vulnerable to major, permanent damage. A large number of significant historic structures could be lost and soil erosion from hydrophobic soils could severely damage archeological resources. Large fires would often encompass a large number of cultural resources including historic structures, cultural landscapes, and archeological sites, resulting in permanent, major, adverse cumulative effects. It is reasonable to assume that the cumulative impacts of all proposed fire management activities would help restore healthy ecosystems, reduce dangerous fuel loads, maintain historic landscapes, and provide opportunities for resource surveys – provided, of course, that proper mitigations are applied. Thus these impacts would be beneficial, moderate, and short- to long-term.

Conclusion

Alternative A would have short-term, moderate, beneficial effects on historic buildings by reducing fuels around these structures, both through prescribed burns and mechanical treatment. Moderate, long-term beneficial effects on cultural landscapes from their restoration or maintenance through prescribed fire or mechanical treatments are also likely. Mitigation measures would keep impacts on archeological resources (from pre-treatment for prescribed burns, or mechanical thinning activities) from becoming more than short-term and minor.

Suppression activities associated even with smaller-sized wildfires could have negligible to major permanent major adverse effects on cultural resources because no pre-planning occurs and suppression, rather than resource protection, is the top priority. Archeological sites could experience permanent adverse major effects from suppression efforts because heavy equipment such as a tractor and blade may inadvertently affect an archeological or historical site. Cultural landscapes would experience only medium-term, moderate, adverse effects from average wildfires because of the regenerative effects of vegetation that should not last more than 10 years.

No adverse or beneficial effects on historic structures, archeological sites, or cultural landscapes are anticipated with the construction of the new fire cache or from implementing research activities.

A large-scale uncontrolled wildfire as described in the “Cumulative Impacts” section above could have long-term, major, adverse effects on historic buildings and cultural landscapes due to significant loss of numerous historic features and structures.

Impairment

Alternative A would not result in long-term impairment of cultural resources.

Alternative B

Analysis

Under Alternative B, fire management actions would focus on the use of mechanical treatment to reduce fire hazards and fuel loads in areas with the highest risks. However, natural and cultural resource goals and objectives would be integrated into the design and implementation of these projects. The use of prescribed fire would occur primarily at Muir Woods National Monument (as described in the "Actions Common to All Alternatives" section above) and in the Park Interior FMU for limited research purposes. Pile burning associated with mechanical treatments would be allowed within the WUI FMU.

The individual nature of mechanical treatment, pile burning, prescribed fire, and wildland fire suppression activities would not change, and neither would their individual effects or recommended mitigations. What would change under Alternative B would be the goals that inform the selection of the individual projects, different acreages associated with each treatment type, and thus the cumulative effects on cultural resources. Under Alternative B, 230 acres would be subject to mechanical treatment and 120 acres would be subject to prescribed burning each year.

Mechanical Treatment

The same types of impacts as described for Alternative A, both beneficial and adverse, would occur as a result of mechanical treatments. However, an additional 130 acres per year would be treated. Although the benefits to cultural landscapes and historic structures would be substantially greater in percentage terms than under Alternative A, they would still be considered short-term and moderate. Also, although impacts on subsurface archeological resources from operations associated with mechanical treatment would potentially cover a wider area than under Alternative A, impacts would remain minor and short-term because of the implementation of the mitigation measures described above.

Pile Burning

Impacts would be the same as under Alternative A.

Prescribed Burning

Impacts would be the same as under Alternative A, except that 10 additional acres per year would be treated by prescribed fire. Therefore, beneficial effects on cultural landscapes and historic structures would be slightly greater. Regarding archeological resources, the potential for a minor, short-term, adverse effects from inadvertent burning of an archeological site would be slightly greater.

Cumulative Impacts

Additional cumulative impacts beyond those described above for Alternative A are expected due to the resource-related goals of this alternative and the additional acres treated. However the level of impact would not change; it would still be beneficial, long-term, and moderate.

Conclusion

Alternative B would have short-term, moderate, beneficial effects on historic buildings by reducing fuels around these structures, both through prescribed burns and mechanical treatment. These benefits would be

greater than under Alternative A, but would remain in the moderate category. Moderate long-term benefits to cultural landscapes would be similar to but greater than under Alternative A, due to the restoration or maintenance of these landscapes through resource-based project criteria and the likelihood of additional acreages receiving mechanical treatments. As under Alternative A, mitigation measures would keep impacts on archeological resources from pre-treatment for prescribed burns, or mechanical thinning activities, from becoming more than short-term and minor. However, the potential for these impacts is greater because both mechanical and prescribed fire programs would treat more acres.

A large-scale uncontrolled wildfire could have long-term, major, adverse effects on historic buildings and cultural landscapes. Suppression and/or mop-up of such a fire could have long-term, major, adverse effects on archeological resources. Suppression activities associated with more average wildfires could also have negligible-to-major impacts on cultural resources. The likelihood of such a wildfire is somewhat reduced by the increased scale of fire management activities, however.

No adverse or beneficial effects on historic structures, archeological sites, or cultural landscapes are anticipated with the construction of the new fire cache or implementation of research activities.

Impairment

Alternative B would not result in long-term impairment of cultural resources.

Alternative C

Analysis

Alternative C proposes use of a broad range of fire management strategies throughout the park – mechanical treatment, pile burning, and prescribed burning – as a means to reduce fuel loading near developed areas and achieve natural and cultural resource enhancement goals. Mechanical treatments, complemented by prescribed fire in all FMUs, would be employed to assist with restoration and maintenance of the park's natural and cultural resources. This alternative would allow for the greatest number of acres to be treated on an annual basis to achieve fire management objectives.

The individual nature of mechanical treatment, pile burning, prescribed fire, and wildland fire suppression activities would not change from Alternative A, and neither would their individual effects or recommended mitigations. What would change under Alternative C would be the goals that inform the selection of the individual projects, different acreages associated with each treatment type, and thus the cumulative effects on cultural resources.

Mechanical Treatment

The same types of impacts as described in Alternative A, both beneficial and adverse, would occur as a result of mechanical treatments. A total of 275 acres per year would be treated. Although the benefits to cultural landscapes and historic structures would be substantially greater in percentage terms than under Alternative A, they would still be considered short-term and moderate. Also, although impacts on subsurface archeological resources from operations associated with mechanical treatment would potentially cover a wider area than under Alternative A, the impacts would remain minor and short-term because of the implementation of the mitigation measures described above.

Pile Burning

Impacts would be the same as under Alternative A.

Prescribed Burning

This alternative would have the same individual effects as Alternative A, except that 210 additional acres per year could be treated by prescribed fire. Therefore, beneficial effects on cultural landscapes and historic structures would be substantially greater. Regarding archeological resources, the potential for a minor, short-term, adverse effect from inadvertent burning of an archeological site would be somewhat greater.

Cumulative Impacts

Additional cumulative impacts beyond those described above for Alternative A are expected due to the resource-related goals of this alternative and the additional acres treated. Although Alternative C would have an overall beneficial effect on cultural resources, the overall level of impact for Alternative C would still be beneficial, long-term, and moderate.

Conclusion

Alternative C would have short-term, moderate, beneficial effects on historic buildings by reducing fuels around these structures, both through prescribed burns and mechanical treatment. These benefits would be greater than under Alternative A, but would remain in the moderate category. Moderate long-term benefits to cultural landscapes would be similar to but greater than under Alternative A, due to the restoration or maintenance of these landscapes through resource-based project criteria and the likelihood of additional acreages receiving mechanical treatments. As under Alternative A, mitigation measures would keep impacts on archeological resources from pre-treatment for prescribed burns, or mechanical thinning activities, from becoming more than short-term and minor. However, the potential for these impacts is greater because both mechanical and prescribed fire programs would treat more acres.

A large-scale uncontrolled wildfire could have long-term, major, adverse effects on historic buildings and cultural landscapes. Suppression and/or mop-up of such a fire could have long-term, major, adverse effects on archeological resources. Suppression activities associated with more average wildfires could also have negligible-to-major impacts on cultural resources. The increased scale of fire management activities significantly reduces the likelihood of such a wildfire, however.

No adverse or beneficial effects on historic structures, archeological sites, or cultural landscapes are anticipated with the construction of the new fire cache or implementation of research activities.

Impairment

Alternative C would not result in long-term impairment of cultural resources.

Impacts on Human Health and Safety

Actions Common to All Alternatives

Wildland-Urban Interface Initiative

Public and Firefighter Safety. The overriding purpose of the National Fire Plan's Wildland-Urban Interface Initiative is to reduce the potential for a catastrophic wildland fire to spread from federal wildlands to adjacent residential communities. At GGNRA, many entities such as local homeowners' associations, fire departments, and local and state land management agencies have received funding for fuel reduction projects outside of the park boundary along the interface zone with GGNRA. The NPS provides funding and compliance services for these projects funded for non-NPS lands. These projects will be addressed as part of the cumulative impact scenario for the FMP.

The NPS also funds projects wholly within the park by granting funding directly to the GGNRA Fire Management Program. One of these projects can be readily seen along Highway 1 in the Tam Valley area, where eucalyptus trees have been thinned along both sides of the highway. Several acres of eucalyptus were also removed from GGNRA lands on Alta Avenue above Marin City and just below a Tamalpais Valley condominium complex on GGNRA lands above Tennessee Valley Creek. Park projects funded by the Wildland-Urban Interface Initiative have also occurred in several areas of the park near Tamalpais Valley and Homestead Valley development. Mechanical fuel reduction was funded to provide limbing up and general fuel reduction for an overly dense stand of Monterey cypress and pine trees at Fort Baker off the main parade grounds adjacent to the historic structures. This project also served to restore a portion of the historic landscape of the parade ground by thinning and removing vegetation back to its original and historic area of planting. Wildland-Urban Interface Initiative funding has also thinned and reduced the eucalyptus woodland around the residences and potentially historic structures at the end of Camino del Canyon Road, where a small community is reached by a single-lane unpaved road with only one access point.

Where Wildland-Urban Interface Initiative projects remove partial stands of nonnative trees, there could be an increased potential for windthrow (tree failure) or windbreak (partial failure such as branches) to occur, posing a safety hazard to visitors. If stands of trees are close to adjacent residences, hazards could be posed to these properties. Under these conditions, Mitigation Measure PHS-1 would ensure that these hazards are considered when projects are evaluated through project review.

To date, the Wildland-Urban Interface Initiative program has had moderate, short- to long-term, beneficial effects on public safety in the wildland urban interface of Marin County. In areas of dense broom and other rapidly regenerating vegetation, the effect is short-term and requires scheduled maintenance to assure that the benefits of the fuel reduction and road improvements will persist. In areas where sizeable stands of eucalyptus and other nonnative trees have been removed, the effect is more long-term, as at least a decade would be needed to fully replace the basal area of the trees that have been removed. Even in areas where eucalyptus trees have been fully removed, maintenance is required for several years to prevent newly sprouted trees from replacing the fuels just removed though application of herbicides or shade cloth to the cut tree stumps, which normally reduce the incidence of resprouting. With

continued funding, the extent of the Wildland-Urban Interface Initiative program will likely be broadened to include projects in the parklands along the interface zone in San Mateo or San Francisco counties.

Public and Firefighter Health. Continued funding of Wildland-Urban Interface Initiative fuel projects within the park could involve a limited amount of pile burning under the direction of NPS staff or the Marin County Fire Department. Smoke generation can be controlled to a certain extent by manipulating the intensity of the piles and the type and structure of the fuel. The amount of pile burning associated with Wildland-Urban Interface Initiative projects within the park has been very low, as much of the cut material is chipped and broadcast onsite. Continued Wildland-Urban Interface Initiative funding for in-park projects would result in a short-term, negligible adverse effect on public and firefighter health.

Much of the fuel reduction accomplished to date on private parcels or locally managed public open space has involved treatment of nonnative plants. Several of these nonnative plants require the direct application of an herbicide to the cut trunk or stalk to produce a better "kill" ratio and to discourage resprouting. All projects within the park are required to use staff or a contractor who is a state-licensed pesticide applicator for this task, to select the proper and least toxic herbicide for the precise project needs, and to protect public health against unnecessary broadcast spraying, unsafe storage, or mixing or application of herbicides under incorrect environmental conditions. Mitigation Measure VEG-6 reinforces the requirement for licensed personnel and requires herbicide use to be administered through the park's integrated pest management (IPM) coordinator, and to report all herbicide use monthly to the GGNRA IPM coordinator.

With the requirement to comply with state law and federal conditions of approval connected to Wildland-Urban Interface Initiative funding, all herbicide application would be completed by a state-licensed applicator and reported to the GGNRA IPM coordinator. There would be no effect on public and firefighter health from herbicide use during community projects.

Defensible Space/Vegetation Clearing Around Structures

Public and Firefighter Safety. The California Public Resource Code (PRC-4290 and 4291) sets a minimum of 30 feet of defensible space around structures to provide the minimum adequate protection from fires. Under the FMP, however, the appropriate clearance around structures would be dictated by the siting of each structure, including slope, vegetation type, construction materials, and potential ignition sources. Providing the required defensible space provides both needed refuge for firefighters and an area from which to safely launch suppression actions. Providing effective defensible space around structures would have a long-term, moderate, beneficial effect on the safety of firefighters and the public.

Public and Firefighter Health. There would be no effect on public or firefighter health by clearing around structures for defensible space.

Roadside Fuel Reduction

Public and Firefighter Safety. A zone of reduced fuels would be maintained along all park roadways that would serve as likely evacuation routes for the public or ingress/egress for emergency vehicles. The width of the zone would be determined by roadway width, roadway composition, vegetation type, slope, and line of sight, among other factors. Vegetation would be cleared to allow unobstructed access for fire

trucks and other large vehicles. Roadsides would be inspected for standing snags or weakened trees that could fall and block roadways during fires. Where roadways cross steep drainages, additional roadside clearance and limbing up of ladder fuels may be required to reduce the potential for the drainage to act as a chimney and accelerate a fire up the drainage toward the roadway. Where appropriate, roadside fuel reduction projects should have a water tender or water pump mounted in a truck available to respond to accidental sparking that can occur with fuel reduction projects when temperatures are very warm. Roadway fuel reduction and the maintenance of the roadside zones of reduced fuel would have a long-term, moderate beneficial effect on firefighter and public safety.

Public and Firefighter Health. There would be no effect on public or firefighter health from roadside fuel reduction.

Suppression

Public and Firefighter Safety. GGNRA lands are sited within the three western counties of the nine-county San Francisco Bay Area, with nearly a 40-mile interface between federal wildlands and residential communities. All wildfires in GGNRA will be suppressed by employing a flexible suppression policy that causes the minimum of resource damage while accomplishing effective control. U.S. Department of the Interior (DOI) wildland fire policy states that all fires are to be classified either as wildland fires or as prescribed burns and all wildland fires must be suppressed. Prescribed fire can be either naturally caused or set to fulfill a prescription. Unplanned human-caused fires will always be suppressed at GGNRA. Although DOI policy states that "prescribed fire, designed to accomplish the management objective of allowing naturally occurring fire to play its role in the ecosystem, will be allowed to burn if provided for in a Fire Management Plan, a valid prescription exists, and the fire is monitored" (National Interagency Fire Center 2001), the risks to life and property are too great to consider allowing unplanned fires to burn.

While federal policy recognizes that wildfire, as a critical natural process, must be reintroduced into the natural environment for the benefit of ecosystem health, the protection of human life must be the first priority for wildland fire management. Property and natural/cultural resources jointly become the second priority, with protection decisions based on values to be protected and other considerations. The bottom line for DOI policy is that no wildfire situation, with the possible exception of threat to human survival, requires the exposure of firefighters to life-threatening situations.

Many larger national parks and forests are in more remote settings farther from large-scale urbanization than is GGNRA. In these larger, more remote parks, naturally occurring fires can burn in areas fully contained within the park and adequately staffed by park firefighters. GGNRA, with many cultural landscapes, hundreds of historic structures, its 40-mile interface zone, and limited fire crew, has few areas where a wildfire could be fully contained. Population and development densities are very high in the park's interface area. The park is spread from north to south at the edge of residential development, so it is often the local fire departments who provide the initial fire response and make initial decisions.

With the initiation of a flexible suppression strategy, the park would engage in an exchange of information and cooperative agreements with local fire agencies. Developing strong relationships would allow the park to share information with area firefighters about the important resources and values in the park. Flexible suppression would allow a response that is the most appropriate to protect park resources

and values while providing the highest protection possible for firefighters, park staff, visitors, and park neighbors, and private property. The park would use methods to suppress wildland fires that minimize impacts of the suppression action without jeopardizing firefighter safety. Another important benefit of a flexible suppression strategy would be the options available to firefighters to use the terrain and resource constraints when crafting a suppression strategy that can incorporate some degree of containment and strategizing in place of direct and immediate suppression being the automatic first response. For example, Mitigation Measure WET-1 calls for fires to be allowed to back into, around, or through wetlands and meadows to avoid suppression damage. The measure specifies that where wetlands are used as a natural boundary to help contain a fire, the control line will be sited outside the wetland area. Trample lines (rather than dug lines) may be used if it is necessary to site the control line in the wetland. This strategy avoids or reduces impacts on the wetland area and reduces the degree of hazard placed on the responding firefighters.

The effect on public safety from flexible fire suppression would be a long-term, moderate, beneficial effect that would acquaint area firefighters with the information they will need to respond safely to a wildfire in GGNRA while meeting the goals for natural and cultural resource protection.

Public and Firefighter Health. Firefighters can be exposed to high levels of particulates, a human health concern, while fighting a wildfire. One control measure for exposure to particulates and other pollutants is controlled crew rotation. If terrain and exertion levels allow, respirators can greatly reduce exposure to particulates and toxins, though they are difficult to use when heavy physical exertion is required. Respirators can be used effectively when firefighters are monitoring one section of a fire to knock down smoldering areas. It is during smolder that the highest levels of particulates are produced, so respirators worn during this period would provide important protection. During suppression action, the health of local residents can be protected by local evacuation and/or announcements to the community at large for people with respiratory problems to remain indoors. The effect on the public from a flexible suppression strategy depends on the severity of the wildland fire. Typically, the fire would produce a short-term, minor, adverse effect on public health in areas subject to smoke. Firefighter working conditions are regulated by the Occupational Safety and Health Act but exposure to particulates from smoke is unavoidable. Impacts on firefighter health would be short-term, adverse, and negligible to minor depending on the hours worked with direct smoke exposure by the firefighter.

Treatment of Muir Woods FMU

Public and Firefighter Safety. The fire management strategy for Muir Woods FMU was developed to strategically reduce the high fuel loading within the park after more than a century of fire suppression. Muir Woods National Monument lies west and downslope from residential development in Homestead Valley on the western fringe of Mill Valley. A very small community at the end of Camino del Canyon is sited within a eucalyptus grove on a dead-end, one-lane, mile-long dirt road on the southern side of Muir Woods Road. Summer visitors to Muir Woods National Monument are wedged into parking lots at the base of a canyon reached by a narrow two-lane road. In case of wildland fire, a rapid evacuation for visitors heading to and already in the park would be a challenge.

Several prescribed burns were completed at Muir Woods National Monument from 1996 to 1999. Continued careful planning of additional prescribed burns, improvement of the defensible space provided around structures in Muir Woods, combined with understory thinning in areas with high incidence of tree mortality caused by SOD, would reduce risks to both the visitors in Redwood Creek Canyon and residents along Panoramic Highway and in Homestead Valley. Prescribed burns would incorporate measures to reduce emissions of particulates that could impede visibility on roadways serving Muir Woods National Monument. The execution of any prescribed burning incorporates a certain level of risk of fire escape; however, reducing fuel loading by implementing the FMP would reduce the overall risk of a large-scale fire that could have major adverse impacts. Prescribed burning at Muir Woods FMU would constitute slightly less than 50 percent of the annual prescribed burning program under Alternative A. The implementation of the combination strategy for Muir Woods FMU would provide a long-term, moderate benefit to public and firefighter safety by reintroducing fire into the redwood ecosystem and by consequently reducing the degree and the potential for a large-scale wildland fire to occur in Muir Woods National Monument by reducing fuel loading.

Public and Firefighter Health. Measures to reduce the health risks to the public and firefighters are discussed under "Alternative A," "Prescribed Burning," below. These measures would be implemented for all prescribed burns executed by GGNRA. Muir Woods FMU would be the site of at least one or two prescribed fires annually. Public and firefighter exposure to particulate matter and other toxins would be limited and would constitute a short-term, adverse, negligible effect on public and firefighter health with health protection measures incorporated.

Treatment of San Francisco County Project Area

Public and Firefighter Safety. Much of the lands in GGNRA within the City and County of San Francisco contain heavily used coastal scrub and nonnative vegetation or beach sand and bluff. In a few areas, very dense, nonnative evergreen forest poses a high fire hazard to the public and firefighters. For example, an area of mature cypress trees on the southern end of Sutro Heights and a dense stand of blackwood acacia near the Lobos Creek channel in the southwestern edge of Area A in the Presidio adjoin residential properties and would benefit from mechanical fuel treatment. Clearing dense vegetation from historic structures throughout the San Francisco parklands would benefit public safety and help preserve the structures in case of a wildfire or structural fire in the area. The fuel reduction strategy for the San Francisco lands would improve firefighter safety by providing areas of defensible space and reducing the risk of a fire spreading from federal lands to the adjacent dense residential neighborhoods. Small research burns in Area A of the Presidio would be explored for implementation in line with recovery plan objectives for threatened or endangered plant species. These burns would be restricted to the relatively undeveloped areas where these species occur. Normally, a water tanker would be sited in the work locations to address unexpected fire behavior. These FMP actions would result in a long-term, moderate beneficial effect on firefighter and public safety.

Public and Firefighter Health. There would be no effect on public or firefighter health from implementation of the strategy for San Francisco lands.

Public Information and Fire Education Programs

Public and Firefighter Safety. Programs that raise the awareness of fire prevention and personal safety and protection would increase awareness within the interface area and with visitors and staff within the park. The exchange of information between park staff and local fire agencies and adjacent residents would help inform park staff about existing fire hazards along the complex interface boundary. An exchange of ideas and cooperation with local fire agencies on prescribed burns, suppression actions, and fuel reduction project planning would improve the level of training and knowledge of both NPS and local agency staffs. The provision of a larger fire education program would have a long-term, moderate beneficial effect on firefighter and public safety.

Public and Firefighter Health. Information on the health effects associated with wildfires and air pollution emissions would be provided as part of public information and education. Alerting those members of the population who would be sensitive to the respiratory effects of high levels of particulates and other toxins would be important. The dissemination of information on how the members of the public may protect themselves would result in a long-term, moderate beneficial effect on public and firefighter health.

Fire Cache

Public and Firefighter Safety. Centralizing and reorganizing the fire suppression equipment in one location in the park would improve public safety by improving the response of NPS firefighting staff and benefit firefighting staff by organizing training facilities and facilitating regular maintenance of equipment and vehicles. The relocation of the fire cache would have a long-term, minor beneficial effect on public and firefighter safety.

Public and Firefighter Health. There would be no effect on public or firefighter health from consolidating the fire cache equipment.

Fire Effects Monitoring

Public and Firefighter Safety. The continuation and expansion of fire effects monitoring at GGNRA contributes to professional knowledge of outcomes of the prescribed burn program and, to a lesser extent, the success of mechanical fuel reduction treatments. Many of the parameters monitored refer to the reaction of natural resources to the application of prescribed burning and do not relate directly to public safety concerns. However, where monitoring addresses the efficacy of prescribed burning in reducing fuel loading and tracking fire behavior, the knowledge base contributing to improve public safety is expanded and benefited. Continuation of the fire effects monitoring program would have a long-term, minor beneficial effect on public and firefighter safety.

Public and Firefighter Health. There would be no effect on public or firefighter health from implementation of the fire effects monitoring program.

Alternative A

Mechanical Fuel Reduction

Public and Firefighter Safety. Mechanical fuel reduction projects would play a relatively small role in the implementation of Alternative A. The principal focus of Alternative A would continue to be the reintroduction of fire into the ecosystem of the park to accomplish natural resource benefits. Though a total of 100 acres would be mechanically treated throughout GGNRA, the majority of the acreage (approximately 70 acres) represents annual roadside fuel brushing and mowing along dirt fire roads and paved access roads in San Mateo and Marin counties. Roughly five acres would be accomplished in San Francisco, continuing to treat dense stands of flammable nonnative plants at critical interfaces with private residential areas or providing defensible space around park structures. Five acres of mechanical treatment would occur at Muir Woods National Monument through understory thinning, as part of shaded fuel break construction, to treat nonnative plants or to the reduce density of nonnative plants such as broom.

The remaining 25 acres would focus on fuel reduction projects in San Mateo and San Francisco counties, targeting dense stands of flammable nonnative plant species, such as eucalyptus or areas with high fuel loading of native plants, e.g., SOD-infected woodlands. The eucalyptus groves in all three counties would continue to be gradually thinned, contained, and/or reduced.

Alternative A proposes relatively gradual reduction in fire hazard in GGNRA. The 1993 FMP did not focus on fuel reduction or the wildland urban interface, concepts that are key to the current federal wildland fire management policy. In the past five years, the National Fire Plan has been funding fuel reduction projects in GGNRA that have primarily been sited in the wildland urban interface near the park boundary. This level of effort would continue under Alternative A, providing a gradual reduction in high fuel loading in the park along the roughly 39-mile interface in the three counties.

Due to the potential hazard of an accidental spark occurring and setting fire to dry vegetation during mechanical fuel reduction, measures assigned through the project review process (Mitigation Measure FMP-1a) may require a water tender, truck-mounted water pump, or backpack pump to be kept at the project site when weather conditions warrant. In addition, the fire management officer, who stays informed on the current daily fire hazard rating, may terminate all mechanical fuel reduction projects when ratings reach a Red-Flag Day or have work stop in the afternoon on high fire hazard days – all to reduce the potential for equipment to cause sparking and ignite a fire.

The mechanical fuel reduction component of Alternative A would have both short-term and long-term, minor beneficial effects on public and firefighter safety through the gradual reduction of areas of high fuel loading and the continued maintenance of zones of reduced fuels along the park fire road network.

Public and Firefighter Health. Mechanical fuel reduction projects contribute significantly fewer pollutants and particulates to the atmosphere than either prescribed burning or wildland fire. Under conditions of poor air quality, a mechanical fuel reduction project could serve as a substitute for prescribed burning as a means to reduce fuel loading. In this respect, mechanical fuel reduction projects release lower levels of air pollutants into the air basin per acre cleared than prescribed burning projects

and contribute fewer adverse effects on air quality. Mechanical fuel reduction also contributes to a reduction of the potential for a large-scale wildfire with its correspondingly large adverse air quality impacts.

Compared to the levels of emissions produced during prescribed fire or wildland fire, the emissions from mechanical fuel reduction (using chain saw, brush-cutters, chippers, etc.) are considered a negligible, short-term adverse effect on public and firefighter health (NPS 2004a, NPS 2004c).

Pile Burning

Public and Firefighter Safety. Pile burning is one of the most important techniques for reducing generation of emissions. The objective of piling debris for burning is to prolong the timeframe that debris will be ignited so that larger materials can be fully consumed by the fire. A greater amount of consumption occurs in the flaming phase and the smoke emission factor is lower.

Burn piles must be carefully constructed, especially on slopes, to prevent failures of the pile and scattering of the ignited fuel. An adequate distance around the pile should be cleared of burnable vegetation to discourage the fire from spreading and provide defensible space for fire monitors. Burn piles should not be left to smolder during the night to avoid the generation of heavy smoke under cooler nighttime conditions. Because of the time restriction, burn piles need to be constructed of the correct volume and materials ideally need to be consumed during the portion of the day allowed for burning. Slightly erratic winds help to disperse and dilute the smoke plume from the piles, but very erratic winds present a safety problem.

When heavy smoke is produced by incorrectly constructed burn piles, they burn more slowly. Without a rising heat column to convey smoke higher into the atmosphere, much of the smoke remains relatively cool and close to the ground. This can result in a smoky fog if moist humid air, such as in coastal fog, makes contact with the smoke plume. This smoky fog can be a significant traffic hazard and require reduced speeds and traffic control to prevent accidents. Conformance with BAAQMD Regulation 5 addressing open burning can reduce the potential for impacts on visibility to occur. As with any prescribed burn, pile burning presents a potential for a fire to escape and cause greater damage. The following are standard best practices employed by GGNRA fire crews for pile burning:

- To minimize impacts on air quality, chipping is the first choice for disposal of fuel reduction debris. Burn piles are selected only where chipping is infeasible.

- All burning, including burn piles, requires the preparation of an NPS burn plan and submittal of a smoke management plan to BAAQMD. The burn plan includes the results of a fire behavior model (BEHAVE) run to simulate fire behavior in the vegetation surrounding the burn pile. The fire behavior model sets staffing and equipment requirements to address that contingency based on predictive fire behavior. The burn plan directs how that level of staffing and equipment would be used to monitor the burn piles or suppress any fire that should spot from or creep from the burn pile. The burn plan describes the environmental setting of the site; how staff and equipment will be deployed prior to, during, and after the fire; how hoses will be deployed; and what the appropriate response is to a change in fire behavior and/or weather.

- Burn piles are encircled by a scratch line, when necessary, to prevent fire creep through duff and vegetation.
- Burn piles are continually tended.
- As piles burn, fuel is pushed into the center of the pile, reducing the combustion area and increasing heat and smoke lift.
- During the course of pile burning, one crew member acts as the dedicated fire monitor who is responsible for updating site-specific weather conditions every half hour to assure that the fire stays within prescription.
- The smoke management plan is based on the results of an emissions generation model and smoke dispersion model. The outcomes of modeling are the amount of emissions from the burn piles and a prediction of smoke dispersal based on the most current weather predictions.
- Changes in weather, including wind speed and direction, and changes in the lift (convection current skyward) of smoke are factors that inform the decision to extinguish burn piles ahead of schedule.

Due to NPS experience and training and BAAQMD requirements for pile burning, the potential for risk of a loss of control of the burn pile is considered a potential short-term, negligible, and adverse effect. The potential for smoke to impede traffic flow and safety is also is considered short-term, negligible, and adverse.

Public and Firefighter Health. The biggest deterrent to pile burning is the relatively high percentage of smoke complaints received from the public because of poorly burning debris piles. Burn piles do not achieve the necessary heat if they are packed too tightly, if material is freshly cut and not yet cured, if too much soil is in the pile, or if the material is too wet. If constructed under these conditions, burn piles can smolder for days producing large amounts of smoke and particulates, a public health concern. Because the pile burns cool when poorly constructed, insufficient heat is produced to draw smoke up above developed areas and roadways. Smoke stays near the ground and even drifts down into other cool areas. If the cool smoke mixes with warm moist air, a smoky fog may form, greatly reducing visibility on roadways. Pile burning produces fewer pounds of particulate per ton of fuel burned.

BAAQMD Regulation 5, Open Burning, requires woody materials to be pile-burned to be set aside to dry a minimum of 60 days prior to ignition. The BAAQMD regulations and training have helped to develop best practices for the construction of burn piles to reduce the generation of pollution emissions. It is best to use low-impact techniques to construct burn piles because heavy equipment can result in mixing large amounts of soil in with the debris to be burned. Soil mixed in with the debris can impede some areas of the pile from fully drying out. Densely packing debris piles with fine fuels can prevent air from circulating and also keep the pile from drying out more quickly after rains. The more that air can circulate during the burn, the greater the heat generated in the pile. This results in fewer particulates generated and more smoke dilution and dispersion by convection away from the ground and sensitive receptors. Burning

when the atmosphere is either still or slightly unstable will also encourage smoke dilution without creating control problems. Freshly cut woody debris must be allowed to cure first and to dry after rain. Freshly cut materials should not be piled when green or wet as this will impede the center of the pile from fully drying.

With the implementation of best practices and conformance with BAAQMD Regulation 5, the potential effect of pile burning on public and firefighter health would be short-term, negligible, and adverse. The public could experience short-term yet negligible adverse effects if the wind shifted from the prescription to an unwanted area.

Prescribed Burning

Public and Firefighter Safety. The primary focus of Alternative A is the prescribed burning of approximately 110 acres annually to achieve resource benefits and secondarily to reduce fuel loading. Limited-scale research burns may be developed for GGNRA lands in San Francisco or San Mateo counties under Alternative A. Research burns would focus on meeting resource enhancement objectives. The primary focus of prescribed burning in Alternative A is to gain natural resource benefits – converting coastal scrub to grassland, confining the spread of Douglas-fir forest into coastal scrub, or treating nonnative plant species. Fuel reduction accomplishments would be a secondary benefit of the burns in most cases.

Public and firefighter safety can be jeopardized when smoke from prescribed fires reduces roadway visibility in the vicinity of the fire. Particulates and other emissions present a public health concern for firefighters, park visitors, and adjacent residents (see “Public and Firefighter Health” below). In addition to health and safety effects, nuisance effects from smoke that result in material damage and soiling can have large economic costs.

Minimization of the effects of smoke can be achieved by careful planning and development of a smoke management plan for each prescribed burn. The requirements for the smoke management plan are detailed in BAAQMD’s Regulation 5-408. The plan must be submitted to BAAQMD’s Air Pollution Control Officer for review at least 30 days prior to receiving approval to proceed with a burn. The NPS also requires a smoke management plan for each prescribed burn or pile burn proposed for national parklands. In 2001, a Guide for Smoke Management of Prescribed and Wildland Fires was developed by the Fire Use Working Team of the National Wildfire Coordinating Group (NWCG) to help publicize new techniques for reducing smoke and emissions.

Prescribed burns generally produce less particulate matter than hotter, more intense wildland fires. Some studies have shown that prescribed burns produce only about one tenth as many particulates as a wildland fire (Biswell 1989). The amount of particulate matter emitted from a fire is directly proportional to the amount of fuel burned. The amount of fuel burned depends on the fuel moisture. Any moisture released from the fuels absorbs some heat energy from the fire, limiting combustion temperatures (Ryan and McMahon in Sandberg 1978). If larger size classes of fuels have high moisture content, most or all of the heat released by flames will be expended evaporating water, and little consumption of large-diameter fuels occurs.

Even a small prescribed fire with low emissions can produce large ground-level impacts if the smoke plume does not disperse but stays close to the ground. Greater smoke plume dispersion can occur when there are mild but erratic winds pushing the plume over ground features that help break up the flow of the plume. In any type of fire, it is the smoldering phase that emits the greatest amounts of particulates and smoke. Because a smoldering fire produces less heat, smoke and particulates are not conducted up into the atmosphere and tend to stay near ground level. When fires burn with a lower intensity, they tend to smolder and burn longer. Smoke plumes trapped by surface temperature inversions can pool in low-lying areas. (BWCAW 2001, Section 3.3). When cool, smoky air encounters patches of moist, warmer air, a heavy smoky fog can result. Poor visibility resulting from the fog can shut down vehicle traffic on adjacent roads (Sandberg et al. 2002).

Mitigation Measure AIR-3 would reduce the generation of smoke by scheduling or rescheduling prescribed burns during seasons when particulate emissions would be reduced. For example, spring prescribed fires would occur when fuels are moister, so less fuel would be consumed and fewer particulates would be emitted. Summer and fall fires tend to burn when fuels are drier, so more fuel is consumed and more particulates are emitted.

Another smoke management technique is to increase the efficiency of combustion during the prescribed fire by increasing combustion of fuels or limiting the amount of fuels. Combustion can be increased through the use of a slower-moving, higher-heat, backing fire. Heading fires, in which the flaming front moves ahead rapidly, burns with a high intensity from one fuel to another but without fully burning most of the larger fuels. A heading fire leaves behind a large area of smoldering fuels that generate large amounts of smoke. Backing fires, used in prescribed burns or to gain control of wildfires, are set to burn more slowly into the wind or downslope, consuming a higher proportion of fuel in the flaming front fire. Backing fires leave less smoldering fuel and residue after passage. For similar burns under similar conditions, use of a heading fire would result in much more total smoke than use of a backing fire, as more fuel would be consumed in the initial burning phases rather than the smoldering phase of combustion.

Mitigation measures to minimize effects on air quality are listed in Chapter 2 (see Mitigation Measures AIR-1 through AIR-6). These same mitigation measures would also minimize potential effects on the health and safety of the public and firefighters by reducing the potential for smoke to adversely affect roadway visibility and reducing production of particulates and other pollutants harmful to humans. The following are standard operating procedures employed by NPS fire staff to reduce the risk of fire escape and address public safety when executing prescribed burns:

- All burning, including burn piles, requires the preparation of an NPS burn plan. Prescribed burns also require submittal of a smoke management plan to BAAQMD. The burn plan includes the results of a fire behavior model run to simulate fire behavior in the vegetation within and surrounding the burn unit of the prescribed burn. This scenario represents a worst-case scenario and it is at that level of readiness that fire planning proceeds. Staffing and equipment is retained to be able to respond to the worst-case model for the conditions of that day in that environment. The burn plan directs how that level of staffing and equipment would be deployed to monitor a

fire and respond to the fire if it were to spread beyond the original burn unit. The burn plan also describes the environmental setting of the site, how the site will be prepared, important resources at the site that should be protected, how hoses and water supplies will be deployed, and the appropriate responses to a change in fire behavior/and or weather.

- The smoke management plan addresses the anticipated production of emissions from the burn piles and a prediction of smoke dispersal based on the most current weather predictions.

- In preparing for a prescribed burn, hose is typically laid along the fire line parallel to the line. Every 200 feet a perpendicular hose lay is placed that can be deployed by the crew for 100 feet on each side of the lateral. The parallel hose lay is charged with water prior to beginning the burn. The laterals can be connected to each section of hose with a T connection to respond to changes in fire behavior.

- During the course of pile burning or a prescribed burn, one crew member acts as the dedicated fire monitor who is responsible for updating site-specific weather conditions to assure that the fire stays within prescription. The fire monitor also gauges the flame length and rate of spread of the fire in real time to determine if the fire is staying within prescription.

- Fire engines with sufficient water to extinguish all piles or a water tender(s) remain onsite throughout the burn period.

- Preparation for a prescribed burn includes establishment of a fire line around the perimeter of the primary burn unit and subunits. Fire lines are developed to minimize impacts on park resources while reducing risk of spread.

- The prescribed fire team is always ready to convert to a suppression team if the conditions shift toward the upper extreme of the prescription.

- A scratch line of exposed bare mineral soil 6 to 8 inches wide is constructed at the edge of the burn unit when necessary, to prevent a fire from creeping through duff into the surrounding vegetation.

- Fire engines and water tenders are recruited to be on duty at the fire based on the outputs of the fire behavior model. Helicopters and other support services are alerted also based on the worst-case scenario predictions of the model.

- Changes in site-specific weather (wind speed, wind direction, relative humidity, fuel moisture, and temperature), changes in the smoke dispersion (reduction of lift, formation of a temperature inversion that could trap smoke close to the ground), and changes in fire behavior (flame length, rate of spread) are factors that inform the decision to extinguish prescribed burns ahead of schedule.

- A large burn unit is often split into smaller burn units, and also can be bordered by a fire line. If conditions warrant, a fire may be stopped ahead of schedule by restricting the spread to a subunit.

- Mop-up is continued until all visible smoke is gone within approximately 150 feet of the fire line.

- Notice of upcoming prescribed burning is posted on adjacent roadways for several days in advance of the prescribed burn. If smoke from the prescribed burn affects visibility and traffic safety on adjacent roadways, sufficient staff will be reassigned to direct traffic. Signs are placed in advance of the areas of poor visibility to warn drivers of the hazard ahead. If roadway visibility becomes too low, traffic may be halted until smoke is dispersed enough to permit safe passage. Also see Mitigation Measures AIR-2 (Smoke Communication Strategy), AIR-4 (avoiding days with the highest visitation) and AIR-5 (selecting meteorological conditions that reduce the potential for smoke drift).

There remains a small but potential level of risk of fire escape with any prescribed burn. With implementation of mitigation measures and best practices, prescribed burning under Alternative A would have a short-term, minor adverse effect on firefighter and public safety during the course of the burn. Over the long-term implementation of the FMP, a minor, beneficial impact would accrue to public and firefighter safety from the overall reduction of fuels.

Public and Firefighter Health. Firefighters are exposed to particulate matter and other pollutants during prescribed burning. The health effects of this exposure have only recently begun to be monitored. During prescribed burns, firefighters work in significantly smoky conditions 5 percent of the time, especially when holding line, attacking spot fires, and supervising these actions (Reinhardt et al. 2000). In the early 1990s, dosimeter monitoring of firefighters working prescribed burns in the Pacific Northwest found that some individuals had been exposed to emission levels exceeding occupational hazard limits (Reinhardt et al. 2000). The chief hazards identified by the dosimeter monitoring were inhalation of carbon monoxide, aldehydes, benzene, and particulate matter of less than 3.5 micrograms ($PM_{3.5}$). Exposure to aldehydes (of which formaldehyde is the most familiar) and $PM_{3.5}$ can cause immediate eye and upper respiratory irritation even at distance of one mile. The levels of carbon monoxide measured at prescribed burns can cause disorientation, nausea, and headache. Exposure to benzene was highest among workers using drip torches and levels observed were low enough to make adverse effects unlikely, though the result of long-term occupational exposure is unknown.

A study of NPS fire crews by the National Institute for Occupational Health and Safety found a slight decline in lung function over the course of a fire season in those crew members who had reported working the most hours. This and several studies of other crews have pointed to some decline in lung function but no long-term studies have been completed. A review of studies conducted to date by Reinhardt et al. for the U.S. Forest Service (USFS) recommends that fire managers of prescribed burns focus concern on exposure of their crews to carbon monoxide and $PM_{3.5}$ (Reinhardt et al. 2000). The exposure levels to benzene did not appear to be significant.

Reinhardt et al. includes the following recommendations for reducing exposure of firefighters to CO, aldehydes, and particulates while working prescribed fires by reducing the time needed to be spent in heavy smoke situations:

- Avoid placing fire lines in difficult-to-defend locations, such as midway up a steep slope.

- Pretreat critical areas that need to be held with water.
- Accept some minor "slopovers" across lines until conditions abate and there is less potential for smoke exposure.
- Use light-weight half-mask respirators during medium- to heavy-smoke situations to limit respiratory exposure to particulates and aldehydes when there are real-time CO monitors available to alert firefighters to hazardous CO levels. (No respirator, except for a self-contained breathing apparatus, offers protection against CO.)
- Reduce time on the fire line and, therefore, exposure to CO for at-risk workers, including those in poor health or suffering from angina or heart conditions, pregnant firefighters, and smokers.

Exposure of firefighters to pollutants in smoke during the course of a prescribed burn would have a short-term, negligible, adverse effect on health. The impact on the public, affected when winds, inversions, or fires out of prescription bring more smoke into residential areas, would be short-term, negligible, and adverse. People with existing respiratory conditions would be advised prior to the prescribed burn to remain inside their homes with the windows closed until the air clears.

Research

Public and Firefighter Safety. The effects of research burns would be similar to those of prescribed burning. There would be a short-term, negligible adverse effect on safety of firefighters working the prescribed burn due to reduced visibility from smoke emissions.

Public and Firefighter Health. There would be a short-term, negligible adverse effect on firefighter health from prescribed burning for research purposes due to inhalation of particulates in smoke from emissions generated during these smaller prescribed burns. Research burns would have no effect or a negligible effect on public health.

Cumulative Impacts

Appendix C lists projects that have potential to contribute to a cumulative impact on the environment when considered in conjunction with the effects of the FMP's implementation. Some of the listed projects could add to the effects on public and firefighter health and safety that could occur under Alternative A. The Fort Baker Plan EIS includes a limited program that would also achieve some level of fuel reduction and enhance public and firefighter safety at the site. The areal extent of nonnative trees that have extended beyond original plantings would be reduced under the EIS and subsequent planning processes. Trees and dense undergrowth in the residential areas would be mechanically removed to improve defensible space around these structures. Additional acreage of mission blue butterfly habitat will be enhanced under an agreement with USFWS; the possibility of using prescribed burning for this enhancement will be investigated. Two recent fires in 2004 show that the area can be affected by arson or illegal campfires. Smoke from wildfires at Fort Baker could have a traffic safety impact on the heavily traveled US 101 at the top of the Fort Baker slope.

The implementation of the PRNS FMP would cumulatively benefit firefighter and public safety, especially in the vicinity of GGNRA lands near Bolinas Ridge. Both parks are strategically reducing fuels in areas of high fuel loading near their common interface. This would improve public and firefighter safety and reduce fuel risk along common boundaries near the town of Bolinas and farther north on the approach to Olema.

The Marin County Fire Department (MCFD) has been very active in developing, proposing, and implementing wildland urban interface projects for homeowners' associations and land management agencies such as the Marin Municipal Water District (MMWD) and the Marin County Open Space District (MCOSD). These two agencies are implementing the Mt. Tamalpais Area Vegetation Management Plan (MT VMP), a comprehensive approach to vegetation management and fire hazard reduction on 20,150 acres of publicly owned open space, parkland, and watershed with an extensive wildland urban interface boundary bordering parts of Mill Valley, Corte Madera, Larkspur, Kentfield, Ross, San Anselmo, and Fairfax in western Marin County. The western boundary of the study area borders GGNRA lands and Mt. Tamalpais State Park. The primary purpose of the MT VMP is reduction of existing fire hazards. Hundreds of detailed prescriptions for treating areas of high fuels were developed to reduce the potential of fire spreading into neighboring communities or damaging watershed resources. GGNRA has had opportunities to date to participate in implementation of some of the detailed prescriptions within the open space by funding projects for MMWD and MCOSD. GGNRA has also funded projects on the private property side of the MT VMP interface by providing funding to the Kent Fire Protection District and MCFD, which have hired local contractors for mechanical fuel reduction projects where residential areas meet the MT VMP study area in Kentfield and Mill Valley. Developed in response to the 1991 Oakland Hills Fire, the MT VMP proposes the construction of zones of reduced fuels totaling roughly 5 percent of the total study area or treatment of 1,100 acres.

The San Francisco Watershed Plan completed in January 2001 called for the development of a fire management plan for the 23,000-acre watershed. The planning area borders part of Sweeney Ridge in San Mateo County east of Pacifica.

Smaller-scale projects in and around GGNRA lands that would contribute to the cumulative effect under Alternative A include habitat restoration efforts throughout the park that sometimes replace more flammable nonnative vegetation with native plants grown in the park nursery from seed collected on parklands. Routine roadside maintenance by park staff is conducted annually and maintains areas of reduced fuels along park roads, fire roads, and trails.

There are some limited opportunities under Alternative A for joint projects across boundaries between GGNRA and MMWD, Marin County Fire Department (MCFD), or other local fire agencies that would result in larger-scale fuel reduction accomplishments. Budgets for all agencies involved have typically limited the scope of annual fuel reduction projects. Nearly every project also requires a revegetation and/or maintenance plan to maintain a treated area in lower fuels for a few years until weeds are controlled. Given the relatively small total of fuel reduction projects that would be accomplished annually under Alternative A, the cumulative impact of all the vicinity fuel reduction efforts would result in a long-

term, minor beneficial effect on public and firefighter safety by lowering the overall risk of a catastrophic fire to occur in the vicinity of GGNRA.

MCFD conducts approximately 50 acres of prescribed burning and burns roughly 50 piles of vegetation debris annually. Occasionally, MCFD will oversee pile burning to reduce debris from community fuel reduction projects funded by the Wildland-Urban Interface Initiative. Dispersed over a wide area in western Marin and occurring within a roughly six-month period, smoke effects from these additional sources would not be sufficiently concentrated to result in a cumulative effect to firefighter or public health under Alternative A.

Conclusion

The assessment considers public and firefighter safety and public and firefighter health for each of the proposed actions in Alternative A. The assessment of public safety focuses on three areas of effects: (1) reducing the existing public safety hazard posed by high fuel loading, (2) the potential for prescribed burns to spread outside of the burn plot and threaten park resources or developed areas, and (3) the potential traffic hazard from reduced visibility due to smoke. The public health assessment focuses on the potential health hazards to firefighters from extended exposure to smoke.

The assessment found that the set of actions common to all alternatives would primarily result in long-term minor benefits to public and firefighter safety by reducing the level of risk posed by a catastrophic fire. Best management practices and mitigation measures for reducing smoke generation found that the principal actions of prescribed burning, pile burning, and mechanical fuel reduction would have short-term, negligible or minor effects on firefighter and public safety, demonstrating the intensive preparation required to enter into prescribed burning with confidence that the fire will be maintained within prescription and under strict control. Projects that remove partial stands of nonnative trees could increase the risk of tree failure from changes in wind strength and direction in the stand. This potential hazard will be included in the review of each such project for NEPA conformance. The conclusion of short-term, negligible and adverse effects on firefighters and public safety illustrates the relatively low level of risk that a prescribed burn or pile burn will escape control.

Cumulative effects would be long-term, minor, and beneficial as all sources work to reduce existing fuel levels and the potential level of risk. Best management practices for limiting the amount of firefighter exposure to particulates are listed and the effects are considered short-term, negligible, and adverse with incorporation of these practices. The distances between the sites generating levels of particulates as part of the cumulative impact scenario are great and no cumulative effect on public health would be incurred from implementation of Alternative A.

Alternative B

Mechanical Fuel Reduction

Public and Firefighter Safety. Compared to the No Action alternative, Alternative B places a greater emphasis on the reduction of high fuel loads and existing fuel hazards in the WUI FMU, especially in Marin and San Mateo counties. Compared to Alternative A, the acreage that can be treated more than doubles under Alternative B, up to 230 acres annually. As is common to all three alternatives, 70 acres

would be accomplished through roadside mowing and fuel reduction, 10 acres by San Francisco projects, and 5 acres in Muir Woods National Monument, a separate FMU. Not including these elements common to all alternatives, 145 acres of hazardous fuels can be treated and reduced per year.

It is assumed that 130 acres, which includes some roadside mowing, would occur in the long, complex interface with residential communities in Marin County. Within the WUI FMU in San Mateo County, 30 acres would be treated annually (including roadside mowing) at the Phleger Estate and Pacifica lands. Over the life of the program, these acreage totals would include some parklands that require regularly scheduled maintenance projects or retreatment. For example, areas with dense stands of broom along fire access roads may require annual treatment for three to five years before roadside fuels are converted to a lower-statured vegetation type. Roadside areas of dense native chaparral with a minimum of nonnative and less invasive vegetation may require a three- to five-year retreatment interval. Of the 130 acres treated annually, in Marin County, a certain proportion of those acres may have already been treated one or more times previously before a vegetation type conversion to less dense and flammable native plant community is achieved. The emphasis on Marin County demonstrates the added risk of wildfire posed to public and firefighter safety by the high incidence of SOD within Marin woodlands. Alternative B would allow more annual treatment of thinning woodlands of SOD-infected fuels and reducing densities of tan oak overall.

Approximately 55 acres in the Park Interior FMU would also be treated, including some roadside fuel reduction. The work in the Park Interior FMU would focus on improving the defensible space provided along fire roads; reducing, containing, and removing stands of nonnative evergreen forest, some of which connect to stands in the Interior FMU; and providing defensible space for cultural and natural resources that are vulnerable to the effects of fire.

An objective of Alternative B is to expedite the reduction of fuels in the WUI FMU of GGNRA in all three counties. With the accelerated fuels treatment scenario in Alternative B that focuses additional effort on the reduction of hazardous fuel in the wildland urban interface, implementing mechanical treatment would have a long-term, moderate beneficial effect on public and firefighter safety.

Public and Firefighter Health. Alternative B more than doubles the number of acres that can be mechanically treated on an annual basis as compared to Alternative A. Alternative B would accelerate the risk reduction of the potential for a large-scale wildfire by more aggressively treating areas with high fuel loading close to residential communities.

Fuel reduction projects contribute significantly fewer pollutants and particulates to the atmosphere than either prescribed burning or wildland fire. Modeling the levels of emissions produced by mechanical fuel reduction projects (using tools such as chain saws, brushcutters, chippers, etc. and vehicles) has consistently shown this activity to contribute a negligible, short-term adverse effect on air quality and on public and firefighter respiratory health (NPS 2004a, NPS 2004c).

Pile Burning

Public and Firefighter Safety. With over twice as much annual acreage that could be treated to reduce fuels, there is a potential for a correspondingly higher level of pile burning to occur as compared to

Alternative A. Pile burning could occur wherever mechanical fuel reduction projects are sited and would occur primarily in Marin County in both the WUI and Park Interior FMUs. With carefully constructed burn piles that conform to the requirements of BAAQMD Regulation 5 and Mitigation Measures AIR-1 through AIR-6 (see Chapter 2), the potential for fire escape or visibility impacts on roadways from pile burning would be short-term, negligible in intensity, and adverse.

Public and Firefighter Health. With a potentially greater number of pile burns occurring annually, there is a greater potential for effects on firefighters from breathing emissions while monitoring pile burns. With the implementation of best practices and conformance with BAAQMD Regulation 5, the potential effect of pile burning on firefighter health would be short-term, minor, and adverse. The public could experience short-term yet negligible adverse effects if the wind shifted from the prescription to an unwanted area.

Prescribed Burning

Public and Firefighter Safety. Alternative B prescription burning is comprised of 70 acres of research-focused prescribed burning sited in the Park Interior FMU in Marin County. In addition, as in Alternative A, the approximately 50 acres of prescribed and research burning in the Muir Woods FMU would also occur under Alternative B. However, unlike Alternative A, prescribed burning in Alternative B would not be sited in the WUI FMU but restricted mainly to the Park Interior FMU and focused on research objectives. Like in Alternative A, no large-scale prescribed burning is proposed for San Francisco or San Mateo counties. Small-scale research burns for resource enhancement objectives may be developed for special habitats or plant species in these two counties.

With prescribed burning limited to the Park Interior FMU and Muir Woods FMU in Marin County, there would be less potential for smoke from prescribed research burns to affect roadway visibility, although Muir Woods Road could potentially be affected. There would also be fewer sensitive receptors for nuisance effects of smoke such as soiling that could result in material damage and have large economic costs.

Minimization of the effects of smoke can be achieved by careful planning and development of a smoke management plan and review and compliance with requirements set by BAAQMD. Mitigation measures to minimize effects on air quality are listed in Chapter 2 (see Mitigation Measures AIR-1 through AIR-6). These mitigation measures would be applied to Alternative B. The mitigation measures would minimize potential effects on the health and safety of the public and firefighters by reducing the potential for smoke to adversely affect roadway visibility. Prescribed burning under Alternative B would have a short-term, negligible, and adverse effect on public and firefighter safety while prescribed burning is implemented due to the unavoidable risk of fire escape. Over the long-term implementation of the FMP, a minor, beneficial impact would accrue to public and firefighter safety from the overall reduction of fuels.

Public and Firefighter Health. The acreage of prescribed burning allowed under Alternative B is essentially the same as under Alternative A. The difference in effect is that under Alternative A, prescribed burning could occur closer to residential communities in the WUI FMU. Under Alternative B, prescribed burning would occur in the Park Interior FMU with less potential for pollutant emissions to affect residential areas on the park boundary. Effects on health of firefighters and visitors as a result of

prescribed burning would be essentially the same in Alternative B as in Alternative A and would therefore be short-term, negligible, and adverse.

Research

Public and Firefighter Safety. Research burns under Alternative B would be more restricted than under Alternative A. Under Alternative B, research burns could be conducted only in the Park Interior FMU in Marin County. There is always a certain potential for a prescribed fire to escape control, and therefore conducting burns for research purposes under Alternative B can be considered to have a potential for a short-term, negligible adverse effect on safety of firefighters and the public.

Public and Firefighter Health. Impacts on firefighter health from research burning under Alternative B would be essentially the same as under Alternative A. In Alternative B, all research burns would be conducted in the Park Interior FMU and remote from members of the public. Burns would not be conducted in the vicinity of residential areas adjacent to the WUI FMU, so neighbors of the park would not be affected by research burning. The public would only be incidentally exposed to smoke from research burns and would not be measurably affected. There would be a short-term, negligible adverse effect on firefighter health from respiration of emissions while working at the site of the research burns.

Cumulative Impacts

Under Alternative B, efforts would be focused on increasing the rate of mechanical fuel reduction as compared to Alternative A. Though the same number of acres is proposed for prescribed burning under Alternative B compared to Alternative A, prescribed burning would be permitted only for small research burns within the Park Interior FMU in Marin County. Under Alternative B, there would be more opportunities to build upon the fuel reduction efforts of outside agencies and homeowner groups with the larger amount of acreage that could be treated for fuel reduction annually. Working with PRNS, more fuel reduction and prescribed burning in the Park Interior FMU could occur near the interface of the two national parks. Thirty acres of mechanical treatment could occur in San Mateo County in the WUI FMU and ten acres could be treated in the Park Interior FMU in San Mateo County. Sweeney Ridge has some boundary area with both the San Bruno residential developments and San Francisco watershed lands, which could present an opportunity for cooperative strategic fuel reduction.

In five years, Alternative B projects could treat and maintain approximately 1,150 acres in reduced fuels. That is more than twice as much area as allowed under Alternative A for mechanical treatment in the same period. Working cooperatively, MCFD, MMWD, MCOSD, California State Parks, and GGNRA could make important progress toward treating some of the most critical areas in Marin County. Given the progress that the other projects will be making concurrently, implementation of Alternative B could result in a long-term, moderate beneficial effect on public safety.

Few of the projects in the cumulative scenario would involve broadcast burning with the exception of approximately 50 acres annually burned by MCFD. Under Alternative B, roughly the same amount of acreage allowed for Alternative A for prescribed burning would be permitted under Alternative B. With winds dispersing smoke, the implementation of Mitigation Measures AIR-1 through AIR-6, and the

oversight of regional requests for burning coordinated and approved by BAAQMD, the project would not have a cumulative impact on public health.

Conclusion

Potential effects of the actions common to all alternatives on the safety and health of firefighter and the public are the same for Alternative B as were described in Alternative A. Alternative B would treat nearly twice the amount of acreage as Alternative A primarily through increased mechanical fuel reduction. The effect on public and firefighter safety from the resultant reduction in overall risk would be a long-term, moderate beneficial effect. As levels of prescribed burning are essentially similar under Alternative B as compared to Alternative A, the level of effect is essentially the same. The effects on firefighter and public safety would be short-term, negligible, and adverse recognizing there is some potential but very limited risk of a fire escaping control, especially in light of the extensive preparations undertaken for any prescribed burn and described under Alternative A. As in Alternative A, the long-term effects accrued by the continual treatment of additional acres would result in a long-term, minor beneficial effect on firefighter and public safety.

Cumulative effects demonstrate the more rapid progress in reducing fuels gained under Alternative B. The cumulative effect on firefighter and public safety would be long-term, moderate, and beneficial compared to minor benefits under the more restricted Alternative A. There would be no cumulative effect on public and firefighter health under Alternative B.

Alternative C

Mechanical Fuel Reduction

Public and Firefighter Safety. Compared to Alternative A, this alternative allows nearly three times as much mechanical fuel reduction (275 acres compared to 100 acres) and 20 percent more than in Alternative B. Of the 275 total acres, 70 acres would be primarily roadside mowing and fuel reduction projects along fire roads and roads used for emergency ingress and egress. Projects would primarily be sited in the Park Interior and WUI FMUs of Marin County with up to 40 acres sited in San Mateo County (including some of the roadside fuel reduction acreage). Fuel reduction projects, and therefore, benefits to public and firefighter safety, would accrue at essentially the same pace in Alternatives B and C. The difference in Alternative C is that greater fuel reduction would be achieved in the Park Interior FMUs in Marin County. Fuel projects that treat roadside stands of dense nonnative flammable plants and that seek to contain, reduce, and thin stands of highly flammable nonnative evergreen trees in the Park Interior FMU would proceed more quickly toward conversion to less flammable or smaller-statured native plant communities. Compared to Alternative A, Alternative C would have a long-term, moderate, and beneficial effect on increasing public and firefighter safety by reducing potential fire risk to park resources and residential communities on the boundary of the park.

Public and Firefighter Health. Similar to Alternative B, Alternative C would more than double the number of acres that could be mechanically treated on an annual basis as compared to Alternative A. Alternative C would accelerate the risk reduction of the potential for a large-scale wildfire by more aggressively treating areas with high fuel loading close to residential communities.

Fuel reduction projects contribute significantly fewer pollutants and particulates to the atmosphere than either prescribed burning or wildland fire. Modeling the levels of emissions produced by mechanical fuel reduction projects (using tools such as chain saws, brushcutters, chippers, etc. and vehicles) has consistently shown that fuel reduction actions under Alternative C would have a negligible, short-term, adverse effect on air quality and on public and firefighter respiratory health (NPS 2004a NPS 2004c).

Pile Burning

Public and Firefighter Safety. With over twice as much annual acreage that could be treated to reduce fuels in Alternative C, there is a potential for a correspondingly higher level of pile burning to occur as compared to Alternative A. Pile burning could occur wherever mechanical fuel reduction projects are sited and would be located primarily in Marin County in both the WUI and Park Interior FMUs. Mechanical treatments in the Park Interior FMU in Marin and San Mateo counties may be preliminary to broadcast burns, in which case no additional pile burning would be needed. With carefully constructed burn piles that conform to the requirements of BAAQMD Regulation 5 and Mitigation Measures AIR-1 through AIR-6, the potential for fire escape or visibility impacts on roadways from pile burning under Alternative C would be short-term and of negligible intensity though adverse.

Public and Firefighter Health. With a potentially greater number of prescribed burns and pile burns occurring annually under Alternative C as compared to Alternative A, there is a greater potential for effects on firefighters from breathing emissions while monitoring burn piles. With the implementation of best practices and conformance with BAAQMD Regulation 5, the potential effect of pile burning on firefighter health would be short-term, minor, and adverse. The public could experience short-term yet negligible adverse effects if the wind shifted from the prescription to an unwanted area.

Prescribed Burning

Public and Firefighter Safety. Up to 320 acres of prescribed burning would be allowed under Alternative C. As in Alternatives A and B, approximately 50 acres of prescribed and research burning in the Muir Woods FMU would occur. Up to 50 acres of prescribed burning could occur in the WUI FMU in Marin County. Under Alternative C, up to 5 acres of burns could be planned for the WUI FMU lands in San Mateo County, while the maximum under Alternative A for all FMUs in San Mateo County is 10 acres.

Prescribed burning in Alternatives A and C would have similar impacts on public and firefighter safety. However, Alternative C also includes an additional 210 acres parkwide than Alternative A. This is where the difference in objectives and effects becomes evident. The total of 320 acres of treatment by prescribed burning permits a large amount of resource-driven projects to occur annually. Because the majority of projects (215 acres) are proposed for the Park Interior FMU, the potential for prescribed burns to escape control and cross into private parcels or properties of other land management agencies remains limited due to the distance from the park boundary. With prescribed burning primarily concentrated in the Park Interior FMU, there is less potential for smoke from prescribed research burns to affect roadway visibility. There are also fewer sensitive receptors in the Park Interior FMU for nuisance effects of smoke such as soiling that could cause material damage and have large economic costs.

As in Alternative A, minimization of the effects of smoke can be achieved by careful planning and development of a smoke management plan and review and compliance with requirements set by BAAQMD. Mitigation measures to minimize effects on air quality are listed in Chapter 2 (see Mitigation Measures AIR-1 through AIR-6) and would also be applied to Alternative C. Prescribed burning under Alternative C would have a short-term, negligible, and adverse effect on public and firefighter safety during the prescribed burn due to the unavoidable risk of fire escape. Over the long-term implementation of the FMP, a moderate, beneficial impact would accrue to public and firefighter safety from the overall reduction of fuels achieved in tandem with cultural and natural resource objectives.

Public and Firefighter Health. The acreage of prescribed burning allowed under Alternative C is nearly triple that under Alternative A. The difference in effect is that under Alternative C prescribed burning could occur close to residential communities in the WUI FMU. In Alternative C, the majority of prescribed burning would occur in the Park Interior FMU where there is less potential for emissions to affect residential areas on the park boundary. However, effects on the health of firefighters would be greater due to the greater number of fires worked during the fire season. The initial studies of respiratory impacts on firefighters appear to infer that the greater the number of hours worked on a fire, the more a firefighter is exposed to smoke, particulates, and other potentially harmful emissions. The studies appear to indicate that the long-term effects are not known but that seasonal effects appear to resolve after the fire season. The effects on firefighter health under Alternative C would be short-term, minor, and adverse.

Research

Public and Firefighter Safety. Research burns under Alternative C would be essentially the same as under Alternative A. Since there is always a certain potential for a prescribed fire to escape control, the conducting of burns for research purposes under Alternative C can be considered to have a potential for a short-term, negligible adverse effect on safety of firefighters and the public.

Public and Firefighter Health. Parameters for research burns would be essentially the same as under Alternative A. There would be a short-term, negligible adverse effect on firefighter health from respiration of emissions while working the research burns.

Cumulative Impacts

Under Alternative C, FMP efforts would be more evenly split between mechanical fuel reduction projects and prescribed burning than Alternative B. The pace of work would allow the quickest results for reducing fuels in critical areas around the park; almost 1,375 acres could be mechanically treated on an annual basis. There would be more opportunities to plan joint projects to strategically reduce fuels across jurisdictional boundaries than in Alternatives A or B. Alternative C would result in a long-term, moderate beneficial and cumulative effect on public safety. Impacts on public health would be similar to those under Alternatives A and B. Prescribed burns conducted by PRNS or MCFD are distant enough from GGNRA lands to avoid a cumulative impact on public health. NPS firefighters assigned to prescribed burns in both parks would rely on best management practices to rotate crews out of areas of heavy smoke.

Conclusion

Flexible fire suppression, treatment of the Muir Woods FMU, and Wildland-Urban Interface Initiative funded projects within the park would all have a long-term, moderate beneficial effect on firefighter and public safety. Firefighters could experience short-term, adverse, negligible-to-minor health effects from exposure to emissions while fighting wildland fires, undertaking prescribed burning, and conducting pile burning for Wildland-Urban Interface Initiative funded projects within the park.

The application of herbicides to cut tree or shrub stumps by a licensed pesticide applicator would have no effect on firefighter or public health with the oversight ensured by the Integrated Pest Management coordinator. The remaining actions common to all alternatives, including relocation of the fire cache, roadside fuel reduction, fire education, fire effects monitoring, and others, would result in long-term, minor-to-moderate beneficial effects.

Under all three alternatives, the comparatively low levels of emissions produced by mechanical fuel reduction would be much more easily dispersed and would result in only short-term, negligible adverse effects on firefighter health. Alternative A, which includes very limited mechanical treatment, would result in a short- to long-term, minor benefit to firefighter and public safety by reducing the overall potential risk of a large-scale wildfire. Alternatives B and C treat nearly the same amount of acreage by mechanical fuel reduction and would result in long-term, moderate benefits to public and firefighter safety.

All three alternatives would result in short-term, negligible adverse effects on firefighter health due to the effects of emissions on respiratory health of the firefighters. All prescribed burning projects include some degree of hazard that the fire could escape from the control of the firefighters. Because Alternative C is significantly larger in scale than the other alternatives, prescribed burning for Alternative C would result in a long-term, moderate beneficial effect on public and firefighter safety.

The three alternatives would result in short-term, negligible, and adverse effects on public and firefighter safety as a level of risk that the fire could escape control, however unlikely, is inherent with any prescribed burn.

Under all alternatives, firefighter health effects were recognized for those actions involving burning. The greatest impacts were found with tending burn piles. Alternatives B and C involve a larger number of burn piles compared to Alternative A. Pile burning, research burns, and prescribed burns would have a short-term, negligible adverse effect on firefighter health due to firefighter exposure to particulates and other emissions while working these fires. No health effects are anticipated for the public from these prescribed burns.

The cumulative impact of all the vicinity fuel reduction efforts would be a long-term, minor beneficial effect on public and firefighter safety under Alternative A but a moderate beneficial cumulative effect under Alternatives B and C due to the increased participation on the part of GGNRA in lowering fuel loading within the WUI FMU. There would be no cumulative impact on public or firefighter health.

Impairment

The effects of the FMP on firefighter and public health and safety would not represent an impairment of important park resources or values.

Impacts on Visitor Use and Visitor Experience

Actions Common to All Alternatives

Wildland-Urban Interface Initiative

The National Interagency Fire Center (NIFC) has granted Wildland-Urban Interface Initiative funding to projects inside GGNRA's boundaries and had funded fuel reduction efforts in communities on the park's interface zone. The project sites within the interface area typically have high fuel loading or require roadside clearance to meet state and local fire code requirements. The Fire Management Office has worked closely with the local community to hold public meetings and develop flyers and posters explaining the scope of the park's projects to park neighbors and visitors prior to the beginning of work. Community groups, park fire staff, and representatives from local fire agencies typically work together to iron out aesthetic issues and determine if modifications can be made to respond to individual's concerns of potential project effects.

Each fire management action would be reviewed for conformance to this EIS Record of Decision by the GGNRA Project Review Committee. This committee will determine the appropriate level of NEPA analysis and assign appropriate routine management practices and mitigation measures as conditions that need to be followed for project implementation. For example, the committee may recommend that fuel reduction be achieved by concentrating on removing nonnative plant species first before cutting less flammable native plants.

Community groups and homeowners' associations have a vested interest in maintaining an aesthetically pleasing landscape in the park when viewed from their privately held or commonly held parcels or when hiking in the park itself. The scope of park projects within the interface area to date has been such that no project has resulted in sizable modifications to park viewsheds. Projects have involved roadside fuel reduction, understory thinning, removal of stands of nonnative evergreen trees, removal of individual trees, and construction of shaded fuel breaks. With the exception of removal of stands of trees, project implementation has not produced easily noticed changes to park viewsheds. In some instances, the removal of dense nonnative vegetation, such as 10- to 12-foot-high French broom, has recovered former viewsheds. Roadside fuel reduction creates a buffer from the edge of the roadway in which grasses and shrubs have been cut and trees have been limbed up. These buffers parallel the road, an established landscape feature, and do not appear as nonconforming elements in the viewshed.

The implementation of Wildland-Urban Interface Initiative-funded projects within the park in the interface zone would have a short-term, negligible-to-minor, adverse effect on aesthetics, access, and soundscape for the duration of project implementation. Trail access to working sites would be closed when conditions may compromise public safety. Efforts would be made to provide detour routes and spotters to escort visitors across the work area, and to allow access to the project sites before and after the work day. Projects close to the park boundary may generate noise that is perceptible at adjacent parcels.

Noise from the cutting, chipping, or hauling of cut vegetation could result in a short-term, minor adverse effect on the park soundscape. Mitigation Measures VUE-1 through VUE-4 would be applied where appropriate (see Chapter 2, Section 2.7, Mitigation Measures).

Defensible Space/Vegetation Clearing Around Structures

Routine annual maintenance includes reestablishing defensible space around park structures to establish an area of low fuels to prevent fire spread to the structure and to provide firefighters with an area from which to launch suppression actions. Once all structures have been treated in GGNRA, clearing defensible space would become largely a maintenance function, with actions at each structure limited to mowing low vegetation, pruning dead branches, and removing hazard trees. Only a short period of time would be spent at each structure once defensible space has been established. Hand tools, such as chain saws and gasoline-driven mowers, would be the most common noise sources. Clearing of defensible space does not involve manipulation of the landscape to the extent that views would be altered. The defensible space component of the FMP alternatives would have no effect on aesthetics, no effect on visitor access or activities, and a short-term, negligible adverse effect on the park soundscape.

Roadside Fuel Reduction

To create zones of reduced fuels adjacent to park fire roads and access roads, a fuel crew or contractor uses chain saws, brushcutters, and pole pruners to selectively cut vegetation within 10 to 15 feet of the road edge. The return interval for maintenance depends on the type of vegetation. Mowers may make a pass over grassy roadside areas to maintain grasses at a low height to discourage bird nesting. Nonnatives, such as French or Scotch broom, may be brushcut to ground level annually before their seed sets to discourage continued sprouting. At GGNRA, the full broom plant, including the roots, is often pulled from the ground, using a weedwrench during the winter when the soils are saturated and the plant pulls out more easily. Tree branches that impede passage of emergency vehicles are limbed as needed using a chain saw. Dead wood within the roadside buffer is cut and laid flat on the ground. After pruning a stretch of road, the crew backtracks and feeds all cut material into the chipper and blows the chips back onto the roadside. The completed project often resembles a shaded fuel break as specimen native shrubs and trees are usually limbed up but left in place.

Roadside clearance widens the appearance of the built environment in the landscape by widening the cleared area represented by the road. The shaded fuel break approach helps feather the outer edge of the roadside fuel zone into the area of undisturbed vegetation, so that the feature has a more natural appearance. Debris generated by brushcutting and pruning is cleared and chipped by the crew and larger sections of trees are laid flat on the ground where felled to decay. In areas that were nearly 100-percent broom, the plants are pulled free, leaving a cleared road edge that revegetates from the existing seed bank with the next rains or is partially planted with native stock from the park nursery. In areas cleared of other nonnative plants, stubble at ground height may be apparent along the road edge until seed bank revegetation with the next rains. Areas with a high proportion of nonnative plants may be treated several years in a row until sprouting from the existing seed bank becomes exhausted.

The aesthetic impact on visitors hiking on treated roads and fire roads would be a short-term, negligible-to-minor adverse impact until less flammable and often less densely-growing native plant species

reestablish. In the long term, the impact on aesthetics would be minor-to-moderate beneficial effects as new viewsheds are revealed and native plants eventually revegetate an area providing more diversity and improved wildlife habitat along the road or trail. Roadside fuel reduction would not normally require road closures, although occasionally a visitor would be asked to wait at the edge of the worksite until a task is completed. A longer delay of 10 to 30 minutes may be required for tree felling. Temporary road closure could be required to ensure visitor safety in the event that regular truck or heavy equipment traffic was needed to move large amounts of chipped materials or felled trees at the site. If a closure is required, notice would be posted a minimum of seven days in advance and an alternate route recommended if at all feasible. Roadside fuel reduction projects would have a short-term, negligible, adverse effect on visitor access.

Noise generation is regular but intermittent as cut brush is gathered and piled. The whine of brushcutters and chain saws has a high nuisance factor. Chain saws and brushcutters typically each generate 110 dBA at close range, resulting in a cumulative noise level of 113 dBA at close range. When noise disturbance is greater than 110 dBA, oral communication between two people is impossible even when shouting.

Without consideration of other dampening or diverting factors, noise attenuates (reduces in sound energy) from a stationary noise source at 6 dB each time the distance from the noise source is doubled. However, it is more realistic to consider the absorption and reflective effect of a vegetated ground surface or a dirt road in reducing noise energy over distance. The attenuation figure normally used is 7.5 dB for a doubling of the distance between source and receptor (Hendriks 1998).

Park visitors hiking on a trail who have a clear line of sight to a fuel reduction crew in the distance using a chain saw and brushcutters would clearly hear the two members of the crew working one half mile distant on a relatively windless day in the interior of the park. To be readily distinguishable, the noise source would need to be at least 5 dB greater than background noise at the point where the visitors are walking. Wind and soft ground further dampen noise levels, but the varying frequencies of these types of tools are readily perceived above ambient noise even at a distance. However, rarely is there a situation in the park without intervening terrain, screening vegetation, wind, or other noise sources over a half mile along a trail. When topography provides line of sight barriers between a noise source and a receptor, noise levels are greatly reduced. Taken as a worst-case situation, however, hikers approximately 300 feet from the work crew would have to raise their voices to communicate. With a 600-foot-long stretch of trail affording a clear line of sight to the crew working, the visitors would experience very high noise levels for approximately 0.1 mile or (at 1 mile per 30 minutes) roughly 3 minutes. At 0.6 mile, the crew's equipment should be imperceptible above background noise in most areas of the park given the additional attenuation of atmosphere and soft ground. A worst-case scenario for noise propagation would have the hikers on a flat, straight trail with no intervening trees or topography and a hard road surface. In this worst case, natural soundscape would be disturbed for 30 minutes as they approached and receded from the noise source.

The previous scenario is presented to illustrate the scale of impact on the park soundscape of one working crew. More realistically, the weekday GGNRA ambient or background noise environment would include

wind noise, aircraft and jet flyovers, and in the WUI FMU where most fuel reduction work would occur, other construction noise and vehicle noise emanating from the adjacent residential neighborhood.

Fuel reduction work would result in short-term, negligible-to-minor adverse impacts on local noise levels on weekdays during normal work hours, especially within the WUI FMU and close to fire and access roads within the park. Nearly all noise generation would occur between mid-August and March 1 to avoid disturbance to birds nesting in the park's vegetation.

Suppression

A flexible suppression strategy uses methods that cause minimum resource damage while accomplishing effective control. The strategy allows for the choice of a range of approaches to confine, contain, or control a wildland fire, based on the actual conditions faced, with input from the park, suppression forces, and adjacent landowners. Flexible suppression incorporates minimum impact suppression tactics (MIST) guidelines (see Appendix G). During suppression, resource management objectives and long-term effects are constantly being reconsidered, and strategies change to respond to wildfire behavior. Tactics that reduce the need for extensive rehabilitation or regrading are preferred. Whenever possible, fires are allowed to burn to natural barriers. This tactic results in the least impact on landscape and vistas in areas with low vegetation such as coastal scrub and grasslands. Use of tracked vehicles such as bulldozers is discouraged in favor of wheeled vehicles such as excavators and skidders if needed.

Wildfire clearly affects the visitor experience, but it can have beneficial effects through reintroduction of fire into the natural landscape, along with potential interpretive and stewardship opportunities. For a flexible suppression strategy to succeed, preparation of information on important resources is required. With the implementation of Mitigation Measure FMP-6 (see Chapter 2, Section 2.7, Mitigation Measures), a flexible suppression strategy would have a long-term, moderate beneficial impact on the visitor experience by potentially reducing the degree of landscape and resource damage incurred during suppression by limiting the most damaging suppression tactics to the least sensitive areas of the park. Fire suppression using MIST tactics and considering site-specific strategies could leave vegetation blackened and burned but topographic features and soils intact rather than trenched or bulldozed. The resource recovery should be significantly shortened if resource values are considered an important factor in the development of an on-the-ground suppression strategy. Mitigation Measures FMP-2, FMP-3, and FMP-6 through FMP-8 would apply (see Chapter 2, Section 2.7).

Treatment of Muir Woods FMU

The goal of the Muir Woods FMU strategy is to make the visitor experience an important part of the fire management actions. Interpretive programs developed by NPS staff have made the fire-adaptive aspects of the coast redwood forest a key element in the story of Muir Woods and its survival, both past and future. Park visitors quickly become familiar with the large, ubiquitous fire scars at the tree's base and the visitor's eye level. Park staff stress that the woods is not a museum but a vital ecosystem adapted to thrive within a certain range of fire conditions. A cherished part of the Muir Woods visit is the opportunity to take a photo of friends or family posed within the fire scar.

Prescribed burning of up to 50 acres annually could be carried out in Muir Woods under all alternatives. A prescribed burn of the Redwood Creek floodplain through the principal old-growth groves would require meticulous planning and consultation with resource agencies. Important issues to consider in principal areas of the park are avoiding degradation of contributing elements of the cultural landscape; avoiding adverse effects on rare or listed plant, fish, or wildlife species; avoiding significant damage to park infrastructure (much of it wooden walkways); and providing an interpretive program for visitors during the preparation, execution, mop-up, and any necessary rehabilitation of the burn area.

A closure of one or more of the principal trails through the old-growth groves may be required for public safety. Monument staff has experience with temporary closure for either safety or resource requirements. Either an alternate route to the grove is established or an independent program is developed for an alternate part of the park. NPS staff for Muir Woods, has found that visitors are very adaptive to changed conditions encountered at the monument provided that care is taken to inform them of the story behind the closure and an alternative program is in place. During the preparation, execution, mop-up, and rehabilitation stages of the fire, it may become necessary to use noise-generating equipment, such as chain saws, that would disrupt the soundscape of the old-growth forest. While use of loud equipment would be kept to a minimum to remain as unobtrusive as possible, interpretive staff at a distance could use the noise as an interpretive opportunity. Noise generation during prescribed burning would be a short-term, negligible adverse impact lasting only as long as crews were present rehabilitating the burn unit.

Visitation to the monument is typically lowest from December 1 to the March 1 each year. However, conditions at the monument are too wet for a successful burn during this period. Prescribed burns have been successfully implemented at Muir Woods in the months of October and November prior to the annual rainy season. These are months with lower, but still significant, visitation (approximately 40,000 to 60,000 visitors per month). October and November prior to winter storms is also a time period when prescribed burning would not affect nesting or breeding activities of rare and endangered animal species found at the monument.

To reduce potential effects on the visitor experience, staff at Muir Woods routinely places notices on Panoramic Highway, informs adjacent residents, and issues press releases when scheduling prescribed burns or significant changes in park access to warn about smoke impacts. Staff will set up staging areas at the entry to the woods to gather visitors in groups, explain the current project, and answer questions. To facilitate visitation during a prescribed burn in the old-growth groves, a staging area could be set up at the intersection of Panoramic Highway and Muir Woods Road to discuss health effects of smoke and warn at-risk visitors of the prescribed burn. If needed, shuttle service could be provided from this intersection to reduce the number of vehicles using the park road in case of an emergency or need to evacuate. Frank's Valley Road is also available as an alternate ingress/egress for emergency vehicles and supporting fire equipment.

Defensible space of up to 5 acres per year would be mechanically cleared in Muir Woods. Dead branches and SOD-affected trees would be limbed up, chipped, and left onsite in accordance with state SOD guidelines. Defensible space would be cleared around structures in the historic residence area above the

administration office and around the structures on Conlin Avenue. Roadside acres of broom species would also be mowed or cut and maintained on a regular schedule.

Based on the standard procedures currently employed to maintain a valuable program for visitors at the monument even during occasional closures, the staging of prescribed burns at Muir Woods and its interpretation is so integrated into the Muir Woods interpretive program that prescribed burning would result in a short-term, moderate beneficial effect on the visitor experience, and a short-term, negligible adverse effect on public access and park soundscape.

Treatment of San Francisco County Project Area

San Francisco fuel reduction projects would occur primarily near the interface of the park boundary with residential areas, with the objectives of fuel reduction along those boundaries. Nearly all fuel reduction would involve thinning, removal, or limbing of nonnative tree species in dense groves or brushcutting nonnative shrubs or grasses. Areas with particularly aggressive nonnative species may need annual treatment over several years and receive out-plantings from the GGNRA native plant nursery. Certain areas are weedy, littered paths providing not only local access to the park but also screening for illegal camping or nighttime gatherings that could become ignition sources for wildfire.

Where fuel reduction projects occur on the park boundary, park neighbors may experience a reduction in screening vegetation along the boundary as dense stands of nonnative plants are removed. Removal of screening vegetation would reduce fire hazard, eliminate hidden illegal campsites, and remove or reduce fire hazards presented by thick stands of nonnative plants. If plants from the GGNRA native plant nursery are available, the park staff would work with neighbors in developing a palette of suitable replacement native plants for the treated area that could provide some screening and increased security, and be less flammable. The effects and treatment of these areas would be similar to roadside fuel reduction. The impact on aesthetics by reducing fuel loading and cleaning out the screening vegetation from these littered areas would be a long-term, minor-to-moderate benefit to park visitors and park neighbors. Projects would not be expected to impede access to any official trails or recreation areas, as there are numerous options and social trails available for detours in the San Francisco lands in the event of a temporary closure of one area. Fuel reduction projects in the San Francisco lands would have a short-term, negligible adverse effect on public access and the visitor experience. Power tool use would result in short-term, negligible-to-minor adverse effects on the park soundscape in the project vicinity for the duration of work.

Mitigation Measure VUE-1 recommends the limitation of project work hours to those typical of construction work, wherever feasible. The fuel reduction projects in San Francisco lands would have short-term, negligible-to-minor adverse noise impacts on adjacent residents and park visitors during implementation.

Public Information and Fire Education Programs

Studies show that public perception and acceptance of fire as a management tool are partially influenced by prior experience and knowledge, and that the public is supportive of the use of fire to achieve management goals (Machlis et al. 2002, citing Carpenter et al. 1986). Surveyed subjects supported

government actions to reduce risk and find a solution, rather than solutions that required the public to change their behaviors to obviate the risk. These preliminary studies indicate that education and interpretive programs in the park, community meetings on wildland urban interface projects, and public meetings on park projects and plans contribute to communication about fire risk. This pre-emergency risk communication educates the public about the risks of wildland fire and ways they can prepare to protect their families, possibly change behaviors, and work cooperatively with fire agencies to develop solutions.

The public information and education program would provide the public with the information necessary to understand the need and strategy behind fire management practices. The program would also serve as a conduit between the public and the Fire Management Office, informing staff of concerns important to visitors and park neighbors. GGNRA staff can inform park neighbors and visitors about the scope of fuel reduction projects and prescribed burns, giving specifics regarding purpose and need, duration, scope, anticipated noise levels, and outcomes prior to the start of work. The public would have a means to convey feedback regarding proposed modifications to projects, problems they see in the field, general questions, and areas of concern. This information exchange would promote the development of a collaborative approach to fuel reduction, which is as important to residents of the interface as it is to GGNRA and its staff.

The public information and education program would have a long-term, minor, beneficial effect on the visitor experience by informing visitors about fire management planning and fire risk reduction. This component of the FMP would have no effect on noise levels, aesthetics, or public access in GGNRA. The information program would also inform the public about the scope of proposed work plans, anticipated outcomes, potential noise levels, and temporary closures and other factors that influence the visitor experience.

Fire Cache

Relocation of the fire cache would not be distinguishable to visitors from other routine park actions and would have no effect on any aspect of the visitor experience.

Fire Effects Monitoring

In many cases, the staff working in the field for the fire behavior monitoring program would be indistinguishable to visitors from other routine park field operations but would impart a sense to visitors that staff, researchers, or volunteers (depending on the uniform worn) are caring for the park and its resources. Field work provides a means for communication between the park and the public and an opportunity to exchange information and insights. Specifically for fire behavior monitors, the interaction provides an opening for increased fire education. The effect of fire effects monitoring on the visitor experience would be a short-term, minor beneficial impact.

Alternative A

Mechanical Fuel Reduction

Roughly 70 percent or 70 acres of the total acreage treated annually by mechanical fuel reduction under Alternative A would involve roadside mowing and fuel reduction projects. This could occur in Marin and/or San Mateo counties along unimproved fire roads and paved access roads. Defensible space around

structures and areas with highly flammable nonnative plants would be treated in Muir Woods (5 acres) and in San Francisco (5 acres) on an annual basis. The remaining acres of mechanical treatment annually could occur in either Marin or San Mateo counties and could be focused on fuel reduction in the interface area between the park and residential communities. Projects and impacts on the visitor experience would be similar to those described for roadside fuel reduction, defensible space around structures, and public information and education in the previous section, "Actions Common to All Alternatives." Projects could involve reducing roadside fuel, clearing defensible space, creating shaded fuel breaks, or containing, thinning, or removing stands of eucalyptus trees or other highly flammable nonnative trees and shrubs or thinning of areas severely affected by SOD. Projects would be sited to strategically reduce fire hazard to sensitive resources, park values, and residential development inside and outside the park.

Noise levels for smaller-scale projects, such as thinning small-diameter trees from woodlands to reduce fuel loading, would be similar to those discussed for roadway fuel reduction under "Actions Common to All Alternatives" above. Projects that propose containment, thinning, or removal of nonnative trees and shrubs could require the use of heavy equipment such as front-loaders, excavators, and skidders to move felled trees into trucks for off-hauling. This creates a more complex noise environment replete with a variety of intrusive noise sources that range in frequency, such as metal clanging or scraping, which has a high nuisance factor.

A worst-case scenario for noise generation is to consider the types of equipment that could be used for the various phases of a tree removal project working simultaneously, for example, one or two chain saws, a skidder, a wood chipper, a diesel haul truck, and an excavator for loading onto the haul truck. Noise levels produced by this activity would be shifting moment to moment depending on which piece of equipment was operating and dominant. Chain saws and chippers produce the highest noise levels, from approximately 100 dBA L_{eq} to 106 dBA L_{eq} at 10 feet (de Hoop and Lalonde 2003). Chain saws are operated in bursts for short periods of time but over several hours. A trailered wood chipper produces nearly the same noise level but could run continuously for an hour as it is continuously fed wood debris.

The staging area for operations for tree removal projects should be selected carefully to place natural barriers and screening vegetation between the noise sources and sensitive receptors such as residential areas on the park boundary and popular trails. As discussed in Mitigation Measure VUE-2, natural barriers to noise such as hills and ridges, and screens such as dense stands of vegetation and wood piles, can be very effective in reducing noise as perceived by sensitive receptors (Hendriks 1998). Wind speed, wind direction, humidity, and air temperature also play an important role in the transmission of sound over distances. Siting a staging area downwind of sensitive receptors would further attenuate noise levels heard by the receptors, except on windless days or days with offshore winds. Work hours would be limited to daytime weekdays when construction-type noise and higher traffic levels are anticipated in residential areas. Without accounting for the noise reduction effect of barriers and screens, noise levels as high as 110 dBA Leq at 10 feet from equipment (chain saws, chipper, haul truck) would be barely perceptible above weekday ambient noise levels at approximately 0.5 mile from the worksite. With topography barriers shielding equipment, noise would be barely perceptible at 0.25 mile. Fuel reduction projects would be limited to July 31 through March 1 to avoid disturbance to nesting birds (see Mitigation

Measures WIL-1 and WIL-2). To date, the typical length of larger projects has been two to three months of weekday work performed primarily by contracting with state-licensed arborists.

Mechanical fuel reduction projects, particularly projects proposed close to the residential areas, have the potential for a short-term, minor-to-moderate, adverse impact on the soundscape of GGNRA. The following mitigation measures would apply.

With the exception of routine hazard tree removal and limited thinning, park fire management staff would avoid temporary closures of areas of the park during fuel reduction projects and attempt to keep visitors, park residents, and the public informed of the scope of larger proposed projects for fuel reduction and any need for temporary closures (see Mitigation Measure VUE-3). Efforts would be made to secure the site at the close of the workday so that closures around a site could be lifted prior to and after working hours (see Mitigation Measure VUE-4).

With the inclusion of Mitigation Measures VUE-3 and VUE-4, fuel reduction project impacts on visitor access would be reduced to short-term, minor adverse effects.

If requested by the public, complex, larger fuel reduction projects in the interface zone that that could affect mid- to close-range viewsheds for residents on the park boundary, would be discussed at a meeting held in the project vicinity and arranged by the park fire management staff. The project scope and schedule would be presented and comments or questions offered by the public for consideration by park staff (see Mitigation Measure VUE-5).

Mechanical fuel reduction projects, depending on the type of resultant visual change, could have a short- to long-term, minor-to-moderate adverse impact on viewsheds in the aftermath of a fuel reduction project that results in large-scale changes to vegetation communities and views from private homes adjacent to the park.

Pile Burning

The effects of pile burning on the visitor experience are primarily visual. Prior to, during, and after the burn, there are opportunities for park staff to be present at the site and conduct ad hoc public information sessions explaining why burning woody debris is necessary, and to discuss alternative treatments and how the site would be stabilized. For public health and safety, on the day of the burn, access to the area where the burn piles are located would be restricted to minimize public exposure to concentrated smoke and particulates.

The primary visual effect is restricted to the area directly around the burn pile. Since pile burning can cause many changes on soil properties, it is important for the area to be stabilized following the burn, if necessary. The seed bank immediately under the burn pile may have been largely incinerated during pile burning, along with much of the organic matter in the very upper soil horizon. The park hydrologist would determine if any amendments are necessary to prepare the area. If available, plants from the GGNRA native plant nursery could be used to revegetate the burn pile sites if the seed bank proves not to be viable.

If necessary, a temporary closure would be posted at access points to the site for reasons of public health and safety. Burn piles would be constructed and ignited to maximize combustion and minimize smoke and particulate emissions. Beyond the immediate area, noise levels would not be perceptibly elevated; little equipment would be needed so no effect on the park soundscape would be expected beyond the area already closed for reasons of public safety.

Pile burning under Alternative A would have a short-term, minor adverse effect on aesthetics and a short-term, negligible adverse effect on public access. There would be no effect on the park soundscape.

Prescribed Burning

Alternative A allows prescribed burning of 110 acres annually, primarily to achieve resource objectives and secondarily to reduce high fuel loading. The effects of prescribed burning in the Muir Woods FMU would be the same under each alternative and are discussed under "Actions Common to All Action Alternatives," "Fire Management Strategy for the Muir Woods FMU" above.

Roughly 100 acres of prescribed burning under Alternative A would be sited in Marin County of which up to 50 acres would be at Muir Woods National Monument. Prescribed burning would focus on meeting natural resource management goals, which could include vegetation conversion, control of nonnative plants, reintroduction of fire back into an ecosystem for resource benefits, or a series of research burns. If the burn unit supports dense stands of nonnative plant species, such as French broom, a consecutive series of annual burns may be required to begin to exhaust the accumulated broom seed bank. Areas with a mix of native plants and nonnative species may be left following a burn to revegetate from the native seed bank and then weeded of nonnative plants for several years to promote the success of native species.

Prior to the prescribed burn, the fire management staff may post notices on trails leading to the site of the proposed prescribed burn and on the GGNRA fire website. NPS staff phone numbers would be included in notices for the public to contact for additional information.

Brief closure of the burn unit would be needed during site preparation, burning, mop-up, and rehabilitation and stabilization. GGNRA would place special effort on maintaining area access to the greatest extent possible while assuring public safety. Long-term stewardship opportunities may be available to the public to help in the successful revegetation of the burn site following stabilization of the project site.

Prior to conducting the prescribed burn, the GGNRA Fire Management Office would submit a smoke management plan to the BAAQMD for approval to burn at least 30 days in advance of the desired burn date. Many prescribed burns are proposed for late summer or early autumn – at the end of bird nesting season and just before the winter rains begin. BAAQMD grants approval for burns based on the estimated emissions that would be produced by the fire in relation to other applications they have received and the weather forecast. If weather conditions shift out of prescription or smoke begins to accumulate close to the ground after the prescribed fire has been ignited, the burn is shut down and the fire is contained, controlled, and mopped-up. (See discussion under "Human Health and Safety," Prescribed Burning" and "Pile Burning.").

Under Alternative A, prescribed burning would have a minor adverse impact on aesthetics and the visitor experience over the short term from the effects of the prescribed fire on the landscape and vegetation as the visitor experiences firsthand the reintroduction of fire into grassland and shrublands. The long-term effect on aesthetics and the visitor experience would be minor and beneficial, as winter rains and revegetation follow the prescribed burn.

Elevated noise levels from park staff using equipment and vehicles during the preparation and execution of the prescribed fire could be perceivable to park visitors at close range to the burn unit. A temporary closure of roads and trails leading to the burn unit would be put into effect for the day of the burn. Elevated noise levels from speech and vehicle and equipment use would be noticeable through the rehabilitation period for the burn unit when the closure for public access would be lifted.

A negligible short-term adverse effect on soundscape and public access would occur restricted to the implementation period of the burn.

Research

Research topics include enhancement of endangered species habitat, effects of fire on SOD-infected woodlands, effects of SOD on fire behavior due to increase tree mortality, and effects of fire on vegetative type conversion. Under Alternative A, a proportion of these acreages subject to prescribed burning could be used for smaller, more focused research burns. Though smaller in scale, research burns require a burn plan, including a smoke management plan, to be prepared. These must be submitted to BAAQMD for approval at least 30 days prior to the proposed burn date, as with any other burns.

Conducting limited size research burns under Alternative A would allow the reintroduction of fire into areas where burning has long been suppressed. Most prescribed burns are conducted just prior to winter rains, and the burned landscape would be quickly replaced in the spring by grassland and shrublands with a flush of new growth and annuals. The short-term, minor adverse aesthetic effect of the burned landscape would be replaced by a long-term minor beneficial aesthetics impact in the spring when the area is revegetated from the seed bank. Similar to prescribed burning, conducting the research burns would have a short-term, negligible adverse effect on public access and no effect on the park soundscape.

Cumulative Impacts

The effects of fuel reduction projects or prescribed burns sited in the background of a viewshed may appear indistinct with time and blend in readily with surrounding features as regrowth occurs in the winter and spring. Wildland-Urban Interface Initiative-funded projects in the community have typically been limited in scope to shaded fuel breaks or roadside fuel reduction projects and have involved very limited ground disturbance or topographic change. The context for assessment of effects on visitor use and visitor experience has a smaller areal extent than many other environmental effects. Unlike air quality, based in a nine-county air basin, impacts on the soundscape rarely penetrate a distance of a quarter mile (with the exception of propelled noise sources such as explosions, gunshots, and aircraft). Noise generated by projects and routine actions listed in Appendix C would need to be within earshot during part of the day when a visitor also passes close to a noisy fuel reduction project in order to result in a cumulative effect on visitor experience. This could occur under the scenario where a fuel reduction project outside the park

boundary is occurring at the same time as a project inside the park. The adverse effect would diminish as the visitor moves away from the noise source. Mitigation Measure VUE-1 recommends that fuel reduction projects adhere to normal work hours of 8 A.M. to 5 P.M. Monday through Friday to the extent possible in light of other constraints and limitations. Fuel reduction projects would generally be sited near or in the urban interface area and would be unlikely to occur within quieter, more remote areas of the park where fire hazard is relatively low. The effect on visitors would be a short-term, negligible or minor cumulative effect lasting only as long as the visitor stayed in the interface area. A long-term effect on the park soundscape could result if a wildland urban interface project on the park boundary removed a stand of nonnative trees or dense vegetation that served to buffer noise levels from a nearby busy street or highway. The effect would be long-term, but only when close to the edge of the park. As the visitor moved away from the interface boundary, the traffic noise would be attenuated with distance. Alternative A would have a short-term, negligible, adverse cumulative impact on soundscape within the park.

Mechanical fuel reductions under Alternative A would be primarily roadside fuel reduction and would rarely require road closures. It would be unusual for several projects in the same area to result in a closure to the public unless one project had inherent hazards that required public closure. Certain projects, as listed in Appendix C, propose construction and would necessitate some level of park closure to allow safe completion. It is possible that a fuel reduction project or prescribed burn could occur in close proximity to an area closed for construction, thereby expanding the closed area. Closures due to FMP actions are generally short – less than a day. If longer closures are required, Mitigation Measure VUE-4 would encourage the park to secure the site so that it could be opened when fuel reduction, construction, or other hazardous activities are not occurring. Cumulative impacts on public access under Alternative A would be short-term, negligible, and adverse.

The alteration of viewsheds through fuel reduction and prescribed burning could occur where more than one FMP project site is within the view of visitors using trails, roads, or other facilities. The view of more than one area blackened by prescribed burning, whether or not both sites are inside the park or not, could be a short-term, minor adverse effect on the visitor experience. Where the risk of fire hazard is too great to permit the temporal spacing of project implementation, and multiple areas must be disturbed within a viewshed over a short time period, a moderate adverse effect on the visitor experience would result. This effect would be unavoidable due to the more compelling risk to public safety or park resources or private property.

Impairment

Impacts on the visitor use and experience would be short-term, if adverse, and would not constitute an impairment of park resources or park values.

Alternative B

Mechanical Fuel Reduction

Mechanical fuel reduction in the WUI FMU in Marin and San Mateo counties is the primary focus of Alternative B. Alternative B presents the park with an aggressive work plan and imperative to reduce fire hazard along park boundaries or stands of vegetation in the Park Interior FMU of the park that could burn into the interface. Approximately 230 acres would be treated annually, including 70 acres of roadside fuel

reduction and mowing along fire and access roads in the two counties. The majority of fuel reduction acreage would be in Marin County in the WUI FMU and to a lesser extent in the Park Interior FMU in Marin County. Approximately 30 acres, of which some proportion would be roadside fuel reduction, is reserved for San Mateo County WUI FMU for the Phleger Estate and the Pacifica lands adjacent to residential development.

As discussed under Alternative A, fuel reduction projects close to residential development have the potential to affect viewshed and screening provided by park vegetation. However, the park has an overriding responsibility to reduce fire hazard along the wildland urban interface. Dense stands of flammable vegetation may screen views into the park or contribute to viewsheds but also greatly influence the degree of risk posed to those residents who live near to public open space. Large-scale fuel reduction projects that would change vegetation communities in areas where vegetation provides foreground viewsheds or screening could be presented and discussed at a community meeting arranged by park fire management staff where public comments could be heard. Impacts on viewsheds could be short-term to long-term depending on the type of vegetation removed. Adverse effects could be minor to moderate depending on the type of regrowth that spontaneously revegetates the site.

Permitting more acreage to be treated annually would not necessarily affect the visitor experience. More acreage does not imply larger projects but rather a greater number of individual projects in distinct and strategic areas in the Marin, Pacifica, or the Kings Mountain interface. Fuel reduction projects would have a short-term, minor adverse impact on aesthetics as perceived by park neighbors and/or park visitors. With incorporation of Mitigation Measure VUE-2, short-term noise impacts of fuel reduction projects would be attenuated to the degree feasible by careful siting of the staging areas. Noise impacts would be short-term, minor, and adverse as in Alternative A. Impacts on public access to park lands would be short-term, minor, and adverse.

Pile Burning

The effects of pile burning on the visitor experience would be similar to those under Alternative A. Though there may be greater incidence of pile burning under Alternative B due to higher levels of mechanical fuel treatment permitted, the disparate locations where burning could occur would be at considerable distances and scattered around the park. The actual area affected would be relatively restricted and should respond to natural soil amendments, if required, as well as out-plantings. The aesthetic effects of pile burning under Alternative B would be the same as under Alternative A. There would be limited closure to allow the pile burning to proceed and no noticeable effect on the park soundscape.

Prescribed Burning

Prescribed burning is restricted 120 acres in the Park Interior FMU in Marin County and the Muir Woods FMU. Prescribed burning of up to 50 acres in Muir Woods is discussed under “Actions Common to All Alternatives,” above. An additional 70 acres of prescribed burning could occur in the Park Interior FMU in Marin County. Because the prescribed burning would be restricted to the Park Interior FMU and Muir Woods FMU, it would be far enough away from the residential areas to avoid aesthetic impacts. Implementation of the burns would require closure of the burn units until just prior to the burn, during

implementation, and through rehabilitation. Depending on competing demands on staff time, park staff would place notices advertising the upcoming prescribed burn at access points to the burn unit at least one week in advance of the period requested for burning and a reminder one day in advance of the burn.

Prescribed burning in GGNRA lands in the Park Interior FMU and Muir Woods FMU in Marin County would result in a short-term, minor, adverse effect on the visual qualities of the landscape. When the winter rains stimulate revegetation and wash ash and burnt material into the soil, effects of prescribed burn would convert to a long-term minor beneficial effect on aesthetics. In addition to the interpretive opportunities this would present, the burn area should experience a flush of new growth and flowers in the spring following the burn. Prescribed burning would have no effect on the park soundscape and a short-term negligible effect on public access due to closure of the burn area prior to, during, and after the burn.

Research

The effects on the visitor experience from prescribed burning for research purposes would be similar to Alternative A. Under Alternative B, all research burns would occur in the Park Interior FMU in Marin County. Research burns would not be restricted to fuel reduction issues but could be focused on natural and/or cultural resource objectives. Alternative B would present opportunities to reintroduce prescribed fire into grassland and shrubland habitats to enhance endangered species habitat, discourage nonnative grasses, and restore cultural landscapes to the period of significance.

The aesthetic effect of the reintroduction of fire into areas that have undergone long periods of suppression would be a minor, adverse effect over the short term. Following revegetation in the spring, the aesthetic effect of the research burns would convert to a long-term, minor beneficial impact. There would be no effect on the park soundscape from conducting the research burns; the effect on public access would be short-term, negligible, and adverse as under Alternative A.

Cumulative Impacts

Cumulative impacts under Alternative B would be similar to those discussed under Alternative A. Alternative B permits more fuel reduction within the WUI FMU than Alternative A. This provides for more projects and/or larger projects per year within the WUI FMU but does not necessarily produce cumulative effects unless other actions in the same vicinity compound the effects. Impacts on the visitor experience from one project occurring in one area would not affect soundscape, viewshed, or access unless the projects are in close proximity.

Impacts on soundscape generally last as long as the visitor remains within the vicinity of the noise sources or, in the case of a park neighbor, as long as the project or projects are ongoing in close vicinity to the residential area. Cumulative project effects on soundscape under Alternative B could result in more neighboring communities being affected by noise during the same period, but this would not compound the noise effect as the project site would be distributed throughout the WUI FMU in the three counties. Impacts on soundscape could be mitigated by Mitigation Measure VUE-2, which directs siting of staging areas to take advantage of natural barriers to noise transmission. Cumulative impacts on soundscape would be short-term, negligible to minor, and adverse.

Cumulative impacts on public access would be the same as under Alternative A and would be short-term, negligible, and adverse.

Impairment

Impacts on visitor use and experience would be short-term, if adverse, and would not constitute an impairment of park resources or values.

Alternative C

Mechanical Fuel Reduction

Allowable acreages for mechanical fuel treatment projects under Alternative C would be similar to Alternative B. The principal difference between Alternatives B and C is that 45 more acres of mechanical treatment would be permitted in the Park Interior FMU in Marin County under Alternative C. As a result of the increased acreage in Marin, fuel reduction projects that would span FMUs in Marin County and be generally larger in scale could be implemented. Projects spanning FMUs would by necessity be sited farther from the actual interface area boundary and nearby residential neighborhoods. There would be less potential for these larger projects to directly affect vegetation that provides views or screening to neighboring homes. In all other respects, the potential effects of Alternative C on aesthetics, soundscape, and public access would be the same as Alternatives A and B. Large-scale fuel reduction projects in the WUI FMU in Marin County or San Mateo FMU that would change vegetation communities in areas where vegetation provided the foreground viewshed or screening vegetation could conform to Mitigation Measure VUE-5 and be discussed at a public meeting. The larger allowable acreage for fuel reduction projects raises the potential for one or more projects to have short-term moderate adverse effects until vegetation greens up with the next rains.

Pile Burning

Impacts on the visitor experience, specifically effects on the park soundscape, public access opportunities, and aesthetics, from pile burning would be the same under Alternative C as under Alternative A.

Prescribed Burning

Impacts from prescribed burning in the WUI FMU under Alternative C could extend into Marin County and to a lesser extent (5 acres allowed annually) San Mateo County. This alternative would provide an important opportunity for visitors to experience preparation, execution, and rehabilitation of a prescribed burn within areas that are used daily for short hikes and dog-walking and that serve as viewshed for adjacent communities. Alternative C would also bring the changed landscape, higher activity level, increased noise level, and temporary access restrictions that accompany the preparation, execution, and rehabilitation around a prescribed burn.

Alternative C would permit larger broadcast burns to occur in the Park Interior FMU in Marin County. Scheduled just prior to the rains in the low grasslands of the Marin Headlands or Tennessee Valley, a broadcast burn could bring a flush of new growth after the winter rains. The visitor experience could be heightened by additional opportunities for exciting interpretative and education programs and site stewardship recruitment for the period after the burn. The effect would be a short-term, moderate, adverse impact on aesthetics and the visitor experience. Preparation and execution of the prescribed burn would

result in increased activity at the proposed burn site and temporarily elevated noise levels from chain saws, vehicle traffic, and human conversation. This would be a short-term negligible adverse impact on the park soundscape. Public access could be curtailed during a one-week period before and after the burn until the site is made secure for public access. This would be a short-term, negligible adverse effect on public access. Over the long term, the reintroduction of fire into a landscape long subject to suppression would result in a long-term, moderate, beneficial effect as the burn unit rebounds with lush regrowth following the winter rains.

Research

The effects on the visitor experience from prescribed burning for research purposes would be similar to Alternatives A and B. Under Alternative C, larger research burns could occur in the Park Interior FMU in Marin County and on a smaller scale in San Mateo County. Research burns would focus on natural and/or cultural resource objectives, such as restoring landscape surrounding military bunkers and other structures. As in Alternatives A and B, Alternative C would reintroduce fire into grassland and shrubland habitats where fire has been suppressed for decades. With research burns timed to occur in early or mid-autumn just before restorative rains, a flush of new growth and flowers could be expected in the spring. Prescribed burning would also present many opportunities for interpretation of cultural and natural resource topics with firsthand evidence of the results. Aesthetic effects immediately following the burn would have a short-term, moderate adverse impact on the visitor experience. Impacts on the soundscape and public access from implementing the research burn would be short-term, negligible, and adverse as under Alternative A.

Cumulative Impacts

Impacts on the visitor experience and visitor use patterns would be equivalent to Alternatives A and B. As in Alternative A, impacts on soundscape would be short-term, adverse negligible effects on park visitors. But the potential exists for a short-term, minor adverse cumulative effect on park neighbors who are stationary receptors of construction noise and/or noise from fuel reduction projects. Public access could be maintained by implementing Mitigation Measures VUE-3 and VUE-4. As in Alternative A, impacts on public access would be short-term, negligible, and adverse, and impacts on viewsheds would be short-term, adverse, and negligible to moderate.

Conclusion

Adoption of a flexible fire suppression strategy would have a long-term, moderate beneficial effect on the visitor experience and aesthetics by incorporation of recommended mitigation that provides trained NPS staff to implement the strategy. The beneficial effect is gained through the application of minimal impact suppression tactics, which could result in significantly less disturbance to parklands during wildfire suppression actions. Implementation of the proposed strategy for Muir Woods National Monument would have a short-term, moderate beneficial effect on interpretation, aesthetics, and the visitor experience, and a short-term negligible adverse effect on public access and the park soundscape. The effect of fire effects monitoring on the visitor experience would be a short-term, minor beneficial impact gained from the interaction between the monitors and park visitors.

The proposed roadside fuel reduction actions and San Francisco fuel reduction strategy would result in a long-term, minor-to-moderate benefit to aesthetics and the visitor experience by clearing out dense stands of flammable, nonnative plants in favor of a lower fuel type along fire roads, access roads, and the city/parkland interface areas in San Francisco, parts of which are frequently used as illegal campgrounds. These actions would have a short-term, negligible-to-minor adverse effect on the vicinity soundscape during normal work hours on weekdays with the incorporation of recommended mitigation.

The implementation of the proposed public information and education program would educate the visiting public and Bay Area residents about the need for fire risk reduction efforts in federal wildlands and residential subdivisions near the park boundaries. Implementation of this program would have a long-term, minor beneficial effect on the visitor experience.

The proposed mechanical fuel reduction of 100 acres annually under Alternative A would have a short-term, minor adverse effect on the visitor experience, public access, and the park soundscape with the incorporation of recommended mitigation measures that make recommendations regarding the siting of staging areas, noticing of trail closures, and provisions for a forum to discuss fuel reduction projects that affect the viewshed and screening of neighboring homes.

The limited prescribed burning and research burning proposed under Alternative A would have a short-term, minor adverse aesthetic impact directly after the fire and a long-term, minor beneficial aesthetic impact with revegetation.

The potential effects of Alternative B are similar to Alternative A even though Alternative B permits more mechanical fuel reduction acreage. The fuel reduction projects would be situated throughout the park interface and, to some extent, in the Park Interior FMU. Impacts on the visitor experience, access, and soundscape would likewise be dispersed so that even if more projects occur, the effect on the visitor experience at one location in the park would not change with the number of locations or the size of project unless the nature of the project changed.

Because Alternative B allows more mechanical fuel reduction than Alternative A, more pile burning could also potentially occur to dispose of the debris from the fuel reduction projects. This would leave more areas aesthetically degraded in the short term where piles are burned, resulting in a short-term, minor, and adverse aesthetic impact that would be remedied by revegetation.

Many of the actions proposed under Alternative C would have similar effects to Alternative A. For example, the effects of mechanical fuel reduction under the two alternatives would be similar. Prescribed burning and research burning, however, would have a larger program under Alternative C and could result in larger broadcast burns in the Park Interior FMU and smaller fuel reduction burns in the WUI FMU closer to residential areas and trail heads. The effects of prescribed burning would be short-term, moderate, and adverse, but following the spontaneous revegetation at the site within one year effects would be long-term, moderate, and beneficial. Because prescribed burning is proposed closer to trailheads and adjacent neighborhoods, the activity leading up to and during a burn could result in a short-term, minor, and adverse effect on the soundscape during implementation.

All other actions that were assessed for effect on the visitor experience and visitor use patterns were determined to have a negligible effect or no effect.

Impairment

Impacts on the visitor experience and visitor use would be short-term if adverse and would not constitute an impairment of park resources or important park values.

Impacts on Park Operations

Analysis

Impacts were evaluated by assessing changes to operations that would be needed to meet the various operational requirements inherent in each of the actions described below. Relative impacts were evaluated for the action alternatives using staff estimates of the funding and labor required for implementation, and these costs were compared to the existing operations, staffing, and funding described in Alternative A. These cost levels were developed using the professional judgments of staff members who are most knowledgeable about the operational activities of the park and most able to anticipate the operational changes needed under each action. The discussion concentrates upon those operations that would be new, undergo major change, or show susceptibility to increases or decreases in operational activity.

The major operational impacts of fire management activities on park operations are most apparent in the arena of the Wildland Fire Office itself and its parent Division of Resource and Visitor Protection, and in the functions of park maintenance, natural resources management, cultural resources management, interpretation and public affairs. It should be noted that in most cases, existing staffing and funding levels are already lower than knowledgeable staff believe necessary to support even the operations needed to fully implement Alternative A. This is largely attributed to (1) the addition of new lands for the park to manage without addition to the operational funding base; (2) assignment of responsibilities in wildland urban interface areas adjacent to, but outside of, park boundaries; (3) the fact that fire program funding for individual projects does not cover all operational funding needs; and (4) more generally, the steady state of overall park operational funding in spite of wage inflation.

Actions Common to All Alternatives

Wildland-Urban Interface Initiative

In 2001, the NPS began implementing provisions of the federal Wildland Urban Interface Initiative program. This program was designed to facilitate cooperative ventures with park neighbors – including other federal agencies, states, counties, private landowners, and local fire agencies – to reduce the potential for wildland fire to burn from federal lands to neighboring properties.

The emphasis of this program at GGNRA is to reduce the density of hazardous fuels that create a risk to lives or property. Working cooperatively with FIRESafe Marin, Inc., Fire Safe San Mateo, neighboring communities, local, county, and state land management fire agencies, and the NPS, through the National Fire Plan, the program has been funding numerous projects that interface with park boundaries to reduce fuel hazards and increase fire prevention, public safety, and fire education. This program would continue under all alternatives.

The emphasis of the program is to reduce the density of hazardous fuels that create a risk to lives or property on the parklands along the interface zone. Some of the functions that park staff perform to support the program are (1) reviewing project proposals submitted for funding; (2) soliciting, processing, and prioritizing community projects; (3) completing necessary surveys and investigations to support NPS compliance findings for community projects; (4) monitoring community projects during implementation; and (5) administering tasks associated with the full program. The effects of implementation of Wildland Urban Interface Initiative projects outside the park that occur on private lands or those managed by local agencies are addressed as part of the cumulative impact scenario.

Additional responsibilities for lands not within the park boundaries cause moderate, short-term adverse effects on park operations. However, since decreased risk to lives and property adjacent to parklands also decreases the risk to the park, the overall effect of this program on park operations is moderate, long-term, and beneficial.

Defensible Space/Vegetation Clearing Around Structures

The protection of all buildings from wildfire within the park would continue under all alternatives. NPS staff or private contractors will continue to reduce fuel loads around park structures in accordance with California Public Resource Code (PRC-4290 and 4291). Individual structures will be assessed to determine the appropriate vegetation treatment base on fuel type, slope, and historic values that may be present.

The protection of all buildings within the park through the creation of defensible space will have a moderate, short-term adverse effect on park operations through increased workload for maintenance staff, diversion of effort from other maintenance needs, and increased workload for park administration if contracted labor is used instead. However, since decreased risk to lives and property is the result of this program, and maintaining defensible space is less work-intensive than is creating it, the long-term effect of this program to park operations is beneficial and major.

Roadside Fuel Reduction

The reduction of hazardous fuels along park roadways will have a short-term, moderate adverse effect on park maintenance operations and park administration for reasons identical to those for the creation of defensible space. However, moderate, beneficial long-term effects on park operations may be anticipated from this program, as these projects are implemented, schedules are established, and selected roads are treated to allow improved access for emergency vehicles and improved egress for evacuation when necessary.

Suppression

The park cooperates with the Marin County Fire Department, the California Department of Forestry, and other local fire agencies for wildland fire protection. The park's Presidio Fire Department takes the lead in structural fire incidents. Because the No Action alternative would continue this arrangement and level of effort, no additional funding or staffing is needed. Therefore no beneficial or adverse impacts are anticipated.

Treatment of Muir Woods FMU

Special consideration of an FMU for Muir Woods, an old-growth redwood forest and a national monument, is based on the area's unique values at risk (first-growth redwoods), the area's high visitation (ignition potential), and an ongoing fire management program for this area that would continue under all alternatives.

During implementation of individual actions, trail closures, relocation or rescheduling of interpretive programs, or stewardship projects may be necessary. During implementation of prescribed burning, red-carded staff from many GGNRA and PRNS divisions may be asked to participate, creating temporary staff shortages in those divisions. Therefore there would be a short-term, moderate, adverse effect on staffing for the other divisions called to assist with prescribed burns, and on natural and cultural resources staff to assess and monitor effects of these burns, comply with regulatory requirements, arrange for possible revegetation and erosion control as well as possible program modifications for the park interpretive program, and trail closures to monitor during prescribed burning in the park. However, over time, as fire hazards are lessened at Muir Woods and operational demands consequently decrease, the long-term effect of this program on park operations is expected to be minor and adverse. These actions and their effects are determined to be the same across all the alternatives.

Treatment of San Francisco County Project Area

Fuel reduction activities in the San Francisco lands of the park will concentrate on mechanical fuel reduction projects and be coordinated with the program to create defensible space around buildings. There are moderate, short-term adverse effects on park operations in the areas of maintenance, resource management, interpretation, and public affairs; however, moderate, beneficial effects on park operations can be anticipated over the long term.

Public Information and Fire Education Programs

The NPS manages an active fire information and education program within the park that also serves local communities. This program assists in teaching NPS employees, volunteers, park partners, other agencies, park visitors and the general public about fire management goals and policies. The effect of this program on park operations is neither beneficial nor adverse since it is a continuation of an existing program.

Fire Cache

Storage of fire equipment and vehicles in a central location would decrease response time to major park assets and facilitate communication between park staff members responsible for fire management. Ideally the fire cache will be housed in a single location at some time in the near future. This will involve a facility strategically located with engine bays for at least two wildland fire engines, including one Type 3 engine. Sufficient office space will be required in addition to areas for crew members and equipment. This cache/wildland station could potentially be an interagency facility in conjunction with the Marin County Fire Department or one of the city fire organizations. In the past, GGNRA has operated a regional mobilization center. As this program could possibly be reactivated it should be given some consideration in planning for future cache needs.

The planning, regulatory compliance, and administrative workload for the creation of a fire cache will be a moderate, short-term adverse effect on park operations. However, the creation of a centralized fire cache at GGNRA would have a beneficial, long-term, major effect on park operations.

Fire Effects Monitoring

The primary purposes of fire effects monitoring are to ensure that fire management activities meet management objectives, to provide guidance to the fire protection agencies within the park, and to ensure that the park collects at least the minimum information necessary to evaluate the park fire management program. Fire effects monitoring is funded from the national fire office, and continued implementation of monitoring can be accomplished with existing staff and expanded to include additional plots on a limited basis. The effects of this program are moderate, beneficial, and long-term.

Alternative A

Analysis

The Golden Gate Wildland Fire Office is staffed for 2004 at the level of 9 full-time-equivalent employees (FTEs). Fire funding for operations is primarily from the National Fire Program. For the last three years, GGNRA has received approximately $700,000 annually for prescribed burns and for wildfire suppression and mechanical treatments in wildland urban interface projects. Nevertheless, for reasons stated at the beginning of the analysis of park operations, the staffing and funding currently available is insufficient to fully carry out the existing fire management program. The Golden Gate Wildland Fire Office would need 4 additional FTEs to provide park-specific fire ecology and fire education outreach expertise, and to manage projects through contracting and oversight. Furthermore, the natural resource staff presently finds itself deficient by 2.25 FTEs in the areas of habitat restoration and planning and the physical science of erosion. Similarly, the cultural resource staff has a deficit of 3.5 FTEs in order to provide necessary survey, monitoring, and assessment of fire management activities to fully implement the existing program, with a total shortfall of 9.75 FTEs for the park.

Mechanical Treatments

Under this alternative, 100 acres per year throughout the park would be treated by mechanical means: 75 in Marin, 5 in San Francisco, and 20 in San Mateo counties. The reduction of hazardous fuels around park facilities would reduce the risk of a catastrophic fire; thus the potential loss of structures, resources, and therefore potential demand on park maintenance, public affairs, and public safety personnel would all be reduced accordingly. The effects of this program on park operations would be moderate, beneficial, and long-term as firefighting emergencies and disruptions are gradually reduced. There will be no direct effects of this program on park operations, however, since the staffing and budget levels for the Wildland Fire Office are assumed to stay the same and mechanical treatments actually carried out in recent years approach the maximum envisioned in Alternative A.

Pile Burning

Since, under this alternative, pile burning would continue to be used in association with mechanical fuel treatments, there would be minor, short-term adverse effects on park operations from this program. The

NPS has been assisted by staff from other parks and local fire agencies, and this assistance would continue to occur under Alternative A.

Prescribed Burning

Under this alternative, a maximum of 110 acres per year, 100 of which would be in Marin County and the remainder in San Mateo County, would be burned using prescribed fire. This is the same maximum limit already in force. The effect of prescribed fire on park operations under this alternative would be to decrease the overall risk of a catastrophic wildland fire damaging park facilities and causing a major disruption to park operations through diversion of personnel and funding. Nevertheless, there would be moderate, long-term adverse effects on park operations from fully implementing this alternative, assuming staff and budget levels for the Wildland Fire Office remain the same. Any kind of burning has a greater impact on all fire-qualified staff and on law enforcement, interpretation, and public affairs operations than does any mechanical treatment.

Research

Additional FTEs would be required to perform research and evaluation under this alternative, particularly in the natural resources, science, and cultural resources divisions. Since this program has not been fully carried out, nor has the full amount of acres been treated in past years, a moderate, long-term adverse effect upon park operations is anticipated in order to address the shortfall.

Cumulative Impacts

The cumulative impacts of fully implementing the projects associated with Alternative A would have a moderate, adverse, long-term effect on park operations. The intensity of this adverse impact may be lessened to minor by scaling back full implementation of Alternative A to the activity levels of recent years.

Conclusion

Staffing and funding currently available to the park are insufficient to fully carry out the existing fire management program described in Alternative A. Moderate, long-term adverse effects on park operations can be anticipated from the full implementation of this alternative due to provision of red-carded employees from other divisions, the need for monitoring, regulatory compliance and restoration, additional interpretive and public affairs workload expected from prescribed burns, and the additional needs of the fire management program to fully carry out the recommended treatments. If implementation of Alternative A is scaled back to conform to existing staff and fiscal limitations, then the adverse effects on park operations may be reduced to minor. Staffing limitations could result in reduced accomplishments and a longer time period needed to achieve FMP goals. The construction of a new fire cache would have a short-term moderate adverse impact on the park's operations and budget, but would have long-term minor benefits by creating new efficiencies in fire management operations. Under any scenario, the suppression of a large-scale wildfire would have a short-term adverse major effect on park operations, management, and budget.

Impairment

This alternative would not result in long-term impairment to park resources and values.

Alternative B

Analysis

Under Alternative B, fire management actions would focus on the use of mechanical treatment to reduce fire hazards and fuel loads in areas with the highest risks. Both natural and cultural resource goals and objectives would be integrated into the design and implementation of these projects. The use of prescribed fire would occur primarily at Muir Woods and in the Park Interior FMU for limited research purposes. Pile burning associated with mechanical treatments would be allowed within the WUI FMU.

The individual nature of mechanical treatment, pile burning, prescribed fire, and wildland fire suppression activities would not change, and neither would their individual effects. What would change in Alternative B would be the goals that inform the selection of the individual projects, different acreages associated with each treatment type, and thus the cumulative effects on park operations. Under Alternative B, 180 acres in Marin County, 10 acres in San Francisco County, and 40 acres in San Mateo County would be subject to mechanical treatment, and 120 acres in Marin County would be subject to prescribed burning.

Mechanical Treatments

Twenty more acres in San Mateo County and 105 more acres in Marin would be treated mechanically under this alternative, compared to Alternative A. It is likely that demands on the park's native plant nursery program would increase, since more acres would be treated and would need post-treatment planting and stabilization. Other effects would be the same as described in Alternative A for prescribed fire, and for the same reasons.

Pile Burning

Increased use of pile burning under this alternative in conjunction with increased mechanical treatments would increase the workload on park staff, with minor-to-moderate, short-term, adverse impacts, but long-term negligible impacts.

Prescribed Burning

In Alternative B there would be a similar amount of acres treated by prescribed burns as in Alternative A, but no burns in San Mateo County. The distinction between this alternative and Alternative A, in this regard, would be a minor and short-term adverse effect on park operations as more park operational resources are deployed to provide maintenance, public information, and public safety support to these efforts. Moderate, long-term adverse effects on park operations can be anticipated from the full implementation of this alternative due to provision of red-carded employees from other divisions, the need for monitoring, regulatory compliance and restoration, increased demands on the native plant nursery for seedlings, additional interpretive and public affairs workload expected from prescribed burns, and the additional needs of the fire management program to fully carry out the recommended treatments.

Research

Because additional areas would be treated, more one-time research projects would be necessary. Thus there would be an additional impact on the park's budget, demands upon park staff, and an increased intensity of effect, though still a long-term, moderate, adverse effect.

Cumulative Impacts

No cumulative impacts beyond those described above for Alternative A would occur. The cumulative impacts of all the projects listed with this proposed action (except large-scale wildfire) would have a long-term moderate, adverse effect on park operations.

Conclusion

Alternative B is somewhat constrained in the types of treatments that can be applied in certain areas, especially in the use of prescribed fire (i.e., no prescribed fire in the WUI FMU, research burning only in the Park Interior FMU and San Francisco). In that regard, it can be assumed that relatively costly mechanical treatments would constitute a greater proportion of the treatment actions than would be the case in either Alternatives A or C, where the use of prescribed fire is less constrained.

Increases in the budget would be required to fully implement Alternative B and conduct additional somewhat larger prescribed burning and thinning. Associated impacts on park operations and management would remain moderate, long-term, and adverse, as in Alternative A. This alternative would require an additional 3.25 FTEs to the 13 FTEs identified in Alternative A in the Wildland Fire Office alone. The one-time funding of a new fire cache would have a short-term, moderate, adverse impact on park operations, but would have long-term minor benefits by creating new efficiencies in fire management operations. Suppression of a large-scale wildfire would have a short-term, adverse, major effect on park operations, management, and budget.

Impairment

The alternative would not result in long-term impairment to park resources and values.

Alternative C

Analysis

Alternative C proposes the utilization of a broad range of fire management strategies throughout the park – mechanical treatment, pile burning, and prescribed burning – as a means to reduce fuel loading near developed areas and achieve natural and cultural resource enhancement goals. Mechanical treatments, complemented by prescribed fire in all FMUs, would be employed to assist with restoration and maintenance of the park's natural and cultural resources. Full implementation of this alternative would allow for the greatest number of acres to be treated on an annual basis to achieve fire management objectives.

The individual nature of mechanical treatment, pile burning, prescribed fire and wildland fire suppression activities would not change from Alternative A, and neither would their individual effects or recommended mitigations. What would change in Alternative C would be the goals that inform the selection of the individual projects, greater acreages associated with each treatment type, and thus the cumulative effects on natural and cultural resources. Under Alternative C, 225 acres in Marin County, 10 acres in San Francisco County, and 40 acres in San Mateo County would be subject to mechanical treatment; 280 acres, less than one acre, and 35 acres, respectively, would be subject to prescribed burning.

Mechanical Treatments

Twenty more acres in San Mateo County and 150 more acres in Marin County would be treated mechanically under this alternative, compared to Alternative A. Effects would be the same as described in Alternative B for prescribed fire, and for the same reasons.

Pile Burning

This alternative would result in the greatest potential use of pile burning over the greatest geographical extent. Short-term impacts on park operations would be moderate and adverse, but long-term impacts would be negligible to minor and beneficial as fuel treatment actions would result in less long-term need to construct burn piles.

Prescribed Burning

In Alternative C there would be 25 additional acres of prescribed burns in San Mateo County and 185 more acres in Marin County, compared to Alternative A. The effects of Alternative C on park operations would be moderate, long-term, and adverse for the same reasons described for Alternative B, only more so, as additional park operational resources would be deployed to support these efforts.

Research

Because substantial additional areas would be treated, more one-time research projects would be necessary. Thus there would be an additional long-term, moderate, adverse impact on the park's operations, as compared to Alternative A, especially in the areas of the Wildland Fire Office and the natural and cultural resource staff.

Cumulative Impacts

No cumulative impacts except those described above for Alternative A would occur. The cumulative impacts of all the projects listed with this proposed action (except large-scale wildfire) would have a long-term, moderate, adverse effect on park operations.

Conclusion

Alternative C is the least constrained alternative in terms of the types of treatments that can be applied in individual areas. Park staff would have more opportunity to learn from field experience and apply those lessons to subsequent projects, and, as additional acres are treated, fire hazard conditions would be improved in more areas of the park. Treating more acres each year would reduce the time necessary to meet FMP goals.

Nevertheless, the additional treatments and acres treated would inevitably have additional impact on the operations of the park if Alternative C is implemented. For the Wildland Fire Office alone, an additional 5 FTEs, compared to the 13 FTEs required by Alternative A, would be needed under Alternative C to conduct prescribed burning and mechanical fuel removals. Alternative C would have a moderate, long-term adverse impact on park operations. These impacts are greater than in Alternative B. However, the benefits of providing fire protection for park facilities would be greater than for Alternatives A and B. The one-time funding of a new fire cache would have a short-term, moderate, adverse impact on park operations, but would have long-term minor benefits by creating new efficiencies in fire management

operations (same as Alternatives A and B). Suppression of a large-scale wildfire would a short-term major adverse effect on park operations (same as Alternatives A and B).

Impairment

The alternative would not result in long-term impairment to park operations and management.

Impacts on Socioeconomics

Impacts Common to All Alternatives

Prescribed Fire and Mechanical Treatments

Prescribed burns and mechanical treatment actions are intended to reduce fuel buildup and enhance the NPS-managed local ecology. Out of a total of about 75,000 total acres within the GGNRA legislative boundary, about 15,000 acres are targeted for fire management activities. The vast majority of land targeted totals 11,000 acres in Marin County, followed by 3,200 acres in San Mateo County (see Chapter 2, Table 2-2). Less than 1,000 acres of land in San Francisco would be affected by prescribed fire and mechanical treatment in any of the project alternatives.

In spite of variations in the level of prescribed burns and mechanical treatment under the three alternatives, the size of the fire management payroll for all alternatives is expected to remain the same or increase only slightly compared to current levels. It is anticipated that economies of scale, use of existing fire suppression units, and other factors would limit the need to increase budgeting or staffing to implement these programs, except as identified in the preceding “Park Operations” section. There may be minor beneficial impacts on the local economy through the use of private contractors to implement selected mechanical fuel reduction efforts; however this is not currently anticipated.

Suppression

The economic impact of fire suppression efforts varies widely depending upon the severity of the ignition. In past years, few fires have been large enough to have a substantial impact on property values or tourism. However, under any of the alternatives, a large-scale fire at infrequent intervals is possible. Socioeconomic impacts of such a fire can be compared with the most recent event in the subject area – by way of example, the Point Reyes National Seashore Vision Fire in 1995. The total economic loss associated with this fire is estimated at $40.15 million according to data included in the Point Reyes Fire Management Plan. Property damage included the loss of 48 homes and damage to an additional 18, resulting in property damage to structures estimated at $37 million. The estimate for public service recovery (road and utility repairs, debris removal and restoration) was $1.8 million. Total suppression costs were estimated at $6.4 million (Marin County Fire Department 1995). Reductions in spending at local businesses were estimated at approximately $1.36 million.

Offsetting the moderate-to-severe short-term adverse impacts of a major unplanned fire are the potential long-term benefits associated with implementing more comprehensive fire treatment activity to restore fuels to more manageable levels. These efforts are being initiated, in part, to reduce the incidence or severity of major wildfires, resulting in a long-term minor-to-moderate beneficial impact on the economy.

Impacts on Tourism

The majority of prescribed burns or mechanical treatments are not expected to result in major road or park closures. Where a temporary, short-term closure is required, alternate routes or park areas are expected to be available. Individual fires would typically be limited in size and completed in a day. In addition, the majority of prescribed burns would be implemented outside of the prime tourist season. From March (and in some cases from January) until the end of July, prescribed burns would be minimized as they overlap with the bird nesting season. Some heavily visited areas may have short-term closures due to smoke, noise, or safety; however, an array of recommended mitigations to address recreation and health impacts would likely result in nominal, if any, impact on overall visitation rates and associated spending. Relevant mitigations include Mitigation Measure VUE-1 regarding work hours, Mitigation Measure VUE-5 to address outreach and education, Mitigation Measure VUE-2 to reduce noise generators; and safety measures included in Mitigation Measures VUE-3 and VUE-4.

Finally, reports provided by NPS indicate that few complaints have been registered in connection with current prescribed burns or mechanical treatments at GGNRA. Given the magnitude, location, and timing of fire management projects, these efforts are not expected to diminish park visitation. Visitors who want to avoid fires or smoke or the noise of mechanical thinning, or are diverted for safety reasons, would likely relocate to an unaffected area within the park rather than alter their travel plans by leaving or shortening their stay.

Impacts on Minority or Low-Income Populations

The actions proposed under all of the alternatives, including prescribed fire, mechanical treatment, and suppression of small or large fires, would have no disproportionate impact on minorities or low-income populations as the majority of nearby lands in the three counties are comprised of middle and upper-middle class residential neighborhoods.

Comparison of the Alternatives

Three levels of prescribed burns and mechanical treatment are established for the project alternatives. Alternative A involves the smallest amount of acreage for treatment by fuel management practices. Alternative B has comparable acreage designated for prescribed burns, but over twice the amount of land targeted for mechanical treatment. Alternative C employs the highest level of fuel management practices, with 275 acres targeted for mechanical treatment and 320 acres targeted for prescribed burns.

Alternative A

Under this alternative, the fire management program would continue to generate negligible long-term beneficial impacts on the local economy in terms of the park's direct transactions with local businesses that supply goods and services for fire management activities, in addition to local spending by fire program employees on housing, food, and goods and services.

As noted previously, Alternative A is associated with the smallest acreage targeted for prescribed burns and mechanical treatments. This level of fuel management would not be expected to change GGNRA's operating budget nor affect local visitation rates. The majority of unplanned ignitions would be small, and would not affect the local economy through staffing changes or decreases in park visitation. The

cumulative socioeconomic impacts associated with larger, periodic fires may have short-term moderate adverse impacts. Over the long term, spending on fire restoration projects would tend to offset the initial loss in revenue attributable to decreases in visitation.

Alternative B

While Alternative B has a larger number of acres targeted for fuel management practices than Alternative A, it is anticipated that the park operating budget and staffing would require negligible or minor increases. Hence, the direct socioeconomic impacts would be comparable with Alternative A.

Visitation rates are also not expected to change noticeably compared to Alternative A, even with the increased areas of treatment. Hence no additional indirect socioeconomic impacts, adverse or beneficial, are projected.

The potential short-term adverse impacts associated with a major fire event would be comparable to Alternative A. Over time, Alternative B may result in slightly fewer wildland fires, as the fuel reduction efforts are more aggressive.

Alternative C

Alternative C would have the largest level of fuel management treatment. As with Alternative B, there would be a nominal increase to the payroll and operating budget required to implement this alternative. Hence, ongoing socioeconomic benefits with GGNRA operating and staff budget would be comparable to Alternative A, with no additional beneficial or adverse impacts on areawide socioeconomics.

Visitation rates are also not expected to change noticeably compared to Alternative A, even with the increased areas of treatment. Hence, there are no additional projected adverse or beneficial indirect socioeconomic impacts associated with Alternative C.

The potential short-term adverse impacts associated with a major fire event would be comparable to Alternatives A and B. Over time, however, Alternative C may result in somewhat fewer unplanned wildland fires as the fuel reduction efforts would be the most aggressive and would be partially aimed at reducing the risk of a catastrophic fire.

Conclusions

Overall, socioeconomic impacts associated with the planned mechanical treatments and prescribed fire activities could be characterized as negligible, short-term benefits under all three alternatives. The budget and payroll associated with fire management practices would be roughly comparable under the three alternatives. Further, while prescribed burns and mechanical fuel removal may result in some short-term closures and restrictions, with the proposed set of mitigations, these fire management activities are not anticipated to have a noticeable impact on tourism to the park.

Unplanned ignitions could result in a range of impacts from wildland fire to large events where life and property are at risk. Catastrophic fires would reduce visitation, which in turn would reduce spending on lodging, food, and travel. However, there would likely be beneficial effects to the same entities, partially offsetting impacts, as a result of increased demand for similar services by fire and other employees

involved in fire suppression and restoration. Hence, the economic impacts of these larger events may have both beneficial and adverse short-term and minor effects.

4.3 Mandatory Sections

NEPA requires that all environmental impact statements address three specific types of environmental effect. The first section below describes what each alternative sacrifices in terms of long-term sustainability to achieve short-term gain. The second section discusses the commitment of any irreversible (permanent loss or non-renewable resource) or irretrievable (short-term loss or loss of renewable resource) commitments of resources an alternative would require. The final section is a summary of any moderate or major adverse impacts that cannot be further mitigated.

Short-Term Use Versus Long-Term Enhancement of Resources

Alternative A

Prescribed burning, mechanical fuel reduction, routine mowing, and roadside fuel reduction would result in mortality of native and nonnative vegetation within the project area and direct or consequent mortality to wildlife that rely on these areas for habitat or that are killed as a result of project implementation. Wildlife prone to areas of dense fuels would be displaced from sites where vegetation would be modified to reduce fire hazard. With the exception of localized, immediate mortality of vegetation and wildlife, and short-term reduction in habitat, the FMP alternatives are focused on promoting sustainability and long-term resource enhancement with minimal short-term resource damage or use. No permanent change to park resources is intended other than reduction in vegetation density, reduction in overall flammability near sensitive resources, and enhancement of native plant communities and habitat through reintroduction of fire or more natural environmental conditions with fire management actions.

The primary objective of the No Action alternative is the long-term enhancement of natural resources through the reintroduction of fire, a vital component of the ecological processes to native plant communities in GGNRA that have evolved with regimes of naturally occurring wildfire at varying frequencies. Alternative A would incrementally contribute to the reintroduction of fire under as near-to naturally-occurring conditions as permitted today with the constraints of using prescribed fire near urbanized areas. Alternative A includes prescribed fire and mechanical fuel reduction actions that would contribute to the long-term enhancement of natural resources by continuing to reduce high levels of fuels that have accumulated throughout the park during the past century of strict fire suppression. Alternative A would promote the long-term enhancement of many critical park resources.

The long-term benefits accrued to natural resources by fire management actions include:

- Reduction in the potential for a higher-intensity, larger-scale wildfire to severely affect or devastate scarce native plant communities and wildlife habitat protected within the park;
- Improvement of wildlife habitat values;
- Enhancement of park soils through nutrient cycling;
- Reduction of overabundance of damaging bacteria and fungi, etc.;

- Fostering of mosaics of plant community types or limiting type conversion due to the absence of fire;
- Protection of listed wildlife species and habitat from higher-intensity wildfire resulting from higher fuel loading; and
- Limitation of the spread or reduction in the acreage of highly flammable nonnative plants that dominate native plant communities that are important park resources.

Alternative A also includes mechanical fuel reduction and prescribed burning activities that would reduce fuel loading and promote life safety and property protection. Fuel reduction projects have a secondary benefit in reducing wildfire threat to important cultural resources in GGNRA. Projects to protect life and safety, reduce fuel loading, and promote the reintroduction of fire into fire-suppressed landscapes would also reduce fuel loading near historic structures, promote the open grassland and low vegetation of pastoral landscape associated with early ranchlands and dairies in Marin County, and promote more open cultural landscapes that were prevalent when the coastal fortifications were in use in Marin, San Francisco and San Mateo counties.

Prescribed fire use and mechanical fuel reduction projects under Alternative A would promote the long-term enhancement of important park viewsheds by reducing encroachment of nonnative forests and converting the perimeter area of the expanding Douglas-fir forest into low-growing native plant communities.

The protection of the park's natural and cultural resources and viewsheds would in turn protect important recreational resources and park aesthetics by enhancing the values that attract visitors. A high-intensity wildfire fed by higher than normal fuel loading and acres of highly flammable nonnative vegetation could significantly alter the quality and composition of the natural and cultural resources that contribute to the park's significance.

Long-term adverse impacts are acceptable due to the beneficial impacts that would be provided, and most long-term adverse impacts would be mitigated to less than significant. Prescribed fires may escape to become wildland fires. However, this risk would be offset by (1) the implementation of best practices, as adopted by the NPS in applying prescribed fire; and (2) the reduced risk of a higher-intensity fire occurring that could severely damage or destroy significant park resources and threaten life and property both within and outside the park boundaries.

Alternative B

Alternative B focuses on the reduction of hazardous fuels within the WUI FMU and the reintroduction of fire for natural and cultural resource benefits in the Muir Woods FMU, and to a lesser degree in the Park Interior FMU. Fuel reduction efforts under Alternative B would affect over twice as many acres each year than under Alternative A and would, therefore, more quickly and effectively implement a long-term enhancement program for park resources. Treating more acreage annually would allow for a more aggressive maintenance program to occur in conjunction with treatment of new acres. With a much

smaller annual program, the efforts of maintenance staff under Alternative A would need to focus on a greater percentage of already treated areas to assure establishment of lower fuel types in place of more flammable, weedy vegetation. Under the more expansive fuel reduction program in Alternative B, regular maintenance projects could account for a smaller percentage of annual treatments while more and more acres would be incrementally and progressively brought into conditions of lower fuel loads each year.

Alternative B has similar long-term enhancement and short-term use effects for prescribed fire as Alternative A, since the acreages involved are nearly the same (120 acres for Alternative B and 110 acres for Alternative A). Prescribed burning under Alternative B would be restricted to the Muir Woods FMU and research burns in the Park Interior FMU, but these burns would have the added advantage of including the restoration or enhancement of cultural landscapes as a project objective.

Short-term impacts related to project activity would result in mortality of native vegetation during initial treatments. Mortality of wildlife in a treatment areas would also occur and habitat values may decrease in the short term, following project implementation. However, this short-term use of resources would be offset by the reduced risk of wildland fire ignition, the spreading of high-severity wildland fires into adjacent residential areas, and the potential for severely damaging important park resources. The short-term use would also benefit the long-term health of native ecosystems by reintroducing fire as a recurrent process under conditions that would mimic the natural regime as much as possible. Implementation of Alternative B would more quickly convert park acres to a more natural and/or reduced fire hazard condition than under Alternative A. Alternative B would therefore be more sustainable than Alternative A and would provide for greater long-term enhancement and long-term protection of resources.

Alternative C

Compared to Alternative A, Alternative C would provide nearly three times as much mechanical fuel reduction and prescribed burning annually. Under Alternative C, the FMP goals would be achieved in a productive, effective, and sustainable manner through a broad scope of treatments and treatment areas allowed annually for fire management actions. Strategic areas of high fuel loading on the park's urban interface could be treated and maintained over a shorter period of time than under Alternatives A and B. Areas of nonnative plants would be treated earlier in the implementation of the FMP and would therefore be treated before populations of nonnative species could expand to affect larger areas. Long-term maintenance schedules could be developed to sustain vegetation management objectives for areas of the park and avoid the accumulation of high fuel loading on the park's perimeter.

Irreversible/Irretrievable Commitments of Resources

Alternative A

No irreversible/irretrievable commitments of resources would occur under Alternative A other than the use of fuels for heavy equipment, vehicles, and tools.

Alternative B

No irreversible/irretrievable commitments of resources would occur under Alternative B other than those described for Alternative A – the use of fuels for heavy equipment, vehicles and tools.

Alternative C

No irreversible/irretrievable commitments of resources would occur under Alternative C other than those described for Alternative A – the use of fuels for heavy equipment, vehicles and tools.

Unavoidable Adverse Impacts

Alternative A

The majority of adverse effects from implementation of Alternative A would be short-term and reduced to a negligible-to-minor level by the application of best management practices or mitigation measures. These effects include the potential for increased erosion following prescribed fire and the resulting potential increase in sedimentation in nearby water resources. Mechanical treatments would result in negligible-to-minor disturbances to soils over limited areas. Suppression actions could result in soil compaction, ground disturbance, and potentially minor, adverse effects on habitat of special status species. The degree of effect is relative to the level of suppression action taken, proximity to the interface, and sensitive resources. Recent wildfires have been limited in scale and have resulted in short-term, minor effects on soils and water quality within watersheds. Parklands recently affected by recent wildfires contained mostly nonnative vegetation and these fires did not affect sensitive native plant or wildlife species.

Some native vegetation would be removed to reduce fuel levels and suppress wildland fires. This would indirectly affect wildlife, especially with the construction of shaded fuel breaks in areas of native vegetation or roadside fuel reduction. During especially dry years, some wetland areas could be affected by prescribed burning, but some beneficial effects, such as the stimulation of the native seed bed, could also occur.

Fuel reduction and prescribed burning would result in short-term, minor adverse impacts on the visitor experience. These would specifically be through short-term impacts on aesthetics from freshly cut areas, burned and blackened landscapes, and short-term trail closures for public safety and health during implementation of a burn plan or use of heavy equipment in constricted areas where safe detours cannot be provided. Short-term adverse, minor effects on the park's soundscape would occur when visitors or residents are in close proximity to heavy equipment or gas-powered tool use.

The potential for a prescribed burn to escape and become a wildfire is an unavoidable impact under Alternative A. However, the NPS employs the use of best management practices, including planning for suppression of a larger fire, into each NPS burn plan.

Mitigation measures for air quality, in conjunction with coordination and approval for burning by BAAQMD, would avoid meteorological conditions that are most conducive to prescribed fire control

problems and public health and safety concerns. Effects on public and firefighter safety from prescribed burning would be short-term, negligible, and adverse.

Implementation of Alternative A would incrementally reduce the potential for a catastrophic wildfire to occur within GGNRA, consequently reducing the potential for the generation of high levels of air pollutants from wildfire. Mitigation measures for air quality, and the requirement for approval of all prescribed burns by the BAAQMD, would minimize the amount of pollutants generated and avoid the periods when these pollutants would have the most potential for harmful effect on Bay Area air quality. However, implementation of Alternative A would have an unavoidable, long-term, minor adverse effect on Bay Area air quality due to levels of particulate matter affecting regional visibility and NOx, as a precursor to ozone; and an unavoidable, long-term moderate effect due to levels of VOC, also a precursor to ozone. The impacts are considered long-term as the effect would recur annually during the FMP's implementation. The actual duration of the effect would be short-term, due to rapid dispersal during typical periods planned and approved for prescribed burning activities.

The use of heavy equipment by persons suppressing wildfires has the potential to damage archeological resources on the soil's surface or subsurface. Flexible suppression tactics would be employed whenever possible, under all alternatives, to reduce the potential for adverse effect, and heavy equipment operators would be directed to less sensitive, previously disturbed areas of the park to control and contain the fire. However, where wildfire is a threat to public safety or important park resources, or private property, it may be necessary to use heavy equipment in areas that have not been previously surveyed for cultural resources; under these circumstances, the potential would exist for long-term, adverse major impacts on cultural resources.

Alternative B

Unavoidable adverse impacts under Alternative B would be similar to those under Alternative A. The effects of prescribed burning would involve roughly the same amount of acreage as under Alternative A. Short-term, negligible-to-minor adverse impacts on soil erosion, sedimentation, and wetlands would occur in conjunction with prescribed burning and mechanical fuel reduction activities.

Effects of suppression actions would be the same as under Alternative A. Potential long-term, adverse major effects on archeological and wetland resources, due to the use of heavy equipment during suppression actions, could also occur under Alternative B. As in Alternative A, suppression actions could also have short-term, minor effects on soils and habitat for the mission blue butterfly and northern spotted owl.

Prescribed burning under Alternative B would have less of an effect on the visitor experience than Alternative A since all prescribed burning would be restricted to small research burns to the Park Interior FMU and Muir Woods FMU. These burn areas would be located away from many of the regularly visited sites adjacent to the WUI FMU that often receive daily use from nearby residents. Fuel reduction actions would most likely be sited nearer to these developed areas and frequently used trails, which would result in short-term, minor adverse effects on the visitor experience (specifically access, aesthetics, and soundscape) for areas closer to the WUI FMU.

As Alternatives A and B would treat roughly the same amount of acreage, and half of that acreage would be the same area/same treatment (i.e., Muir Woods FMU understory burning) the air quality effects would be essentially the same under each. As in Alternative A, Alternative B would result in a long-term, minor adverse effect on regional visibility through generation of particulate matter. (The Bay Area Air Basin is in attainment for federal standards for particulate matter.) Similar to Alternative A, implementation of Alternative B would produce less than 5 tons per year of NOx – a long-term, minor, adverse effect – and higher relative levels of VOC, resulting in a long-term, moderate adverse effect on air basin VOC emissions. Effects would be considered long-term due to the roughly 15-year implementation period of the FMP.

The annual acreage treated under Alternative B would appreciably and strategically reduce the potential for a wildland fire to occur or to spread to adjacent residential areas, in comparison to Alternative A.

Alternative C

Adverse effects of suppression actions on soils, cultural resources, and wetlands would be similar under Alternatives A and C. Effects of prescribed burning and mechanical treatments on soils, water quality, and special status species would be similar in these two alternatives.

Implementation of Alternative C would have a greater effect on the visitor experience than Alternative A. Larger prescribed burns would be allowed in parklands in San Mateo and Marin counties, and larger burns could exacerbate the short-term adverse effects to a minor-to-moderate level in areas of important access and aesthetics. Firefighter health effects would be short-term, minor, and adverse as firefighters would be exposed to more smoke over the course of a fire season under Alternative C.

On an annual basis, Alternative C would generate higher levels of particulate emissions compared to Alternative A. This would be a result of the treatment of a greater number of acres each year by prescribed burning, as well as the higher percentage of understory burning that would occur under in Alternative C. Alternative C would contribute approximately 110 tons per year of PM_{10}, a level of effect that is considered long-term, moderate, and adverse on regional visibility. The effect would be considered long-term over the FMP's 15-year implementation period. Effects would occur annually over that period.

On an annual basis, Alternative C would produce the highest amount of ozone precursors (VOC and NOx) at levels representing a long-term, moderate adverse effect on air basin air quality for each of these pollutants.

The annual acreage treated under Alternative C would appreciably reduce the potential size or severity of a catastrophic wildfire, compared to Alternative A.