2. FIRE MANAGEMENT STRATEGIES

2.1 FIRE MANAGEMENT GOALS

As part of the NEPA process for the FMP, Pinnacles staff developed goals for the overall fire management program based on guidance from Federal Wildland Fire Management Policy, NPS Management Policies, Director's Order #18, and other fire-related guidance documents. DO-18 identifies three paramount considerations for each NPS unit's fire management program:

- Protect human life and property both within and adjacent to the Monument;
- Perpetuate, restore, replace, or replicate natural processes to the greatest extent practicable; and
- Protect natural and cultural resources and intrinsic values from unacceptable impacts attributable to fire and fire management activities

Using these national goals as a foundation, NPS staff developed goals and objectives specifically for the Pinnacles National Monument Fire Management Plan.

Goal 1. Suppress all wildfires considering firefighter and public safety, while maintaining consistency with resource objectives.

Objectives:

√ Insure all fire management activities sustain no injuries to the public and ensure that the number of fire management staff lost time injuries does not exceed 60% of the 1999-2003 five year average.

√ Complete a risk analysis for properties adjacent to the Monument by 2008.

Goal 2. Implement a prescribed burn program that will address the ecological needs of plant and animal communities in the Monument, with special emphasis on the chaparral ecosystem.

Objectives:

√ Review and evaluate monitoring data every five years to determine the influence of fire on the ecosystem.

√ If it is determined that over a 10-year period of time there has not been a fire >2,500 acres, a prescribed burn up to this size can be conducted in areas of the Monument that have not burned in the previous 25 years (NPS 2006c, page 7.

Goal 3. Reduce hazard fuels accumulations in defensible space areas.

Objectives:

- √ Change fuel conditions around structures in developed areas so that, by 2008, under extreme weather conditions, predicted flame lengths will be less than 4 feet. Vegetation around structures will be treated to create defensible space 100 feet wide or more, based on the condition of adjacent fuels.
- √ Identify areas along roads that potentially could inhibit egress during fire events and treat areas to reduce the potential threats to expedient evacuation of staff and visitors during a fire event. Annually review roads for proper clearances regarding egress in an emergency and retreat areas as needed.
- √ Annually maintain minimum clearances directly adjacent to roads, <2 feet, to reduce the potential for spread of fires from these corridors and to increase firefighter safety.

Goal 4. Manage all wildfire incidents in accordance with accepted interagency standards, using appropriate management strategies and tactics, and maximizing efficiency via interagency coordination and cooperation.

Objective:

- √ Annually review and update existing cooperative agreements and the FMP with state and local agencies in order to facilitate close working relationships and mutual cooperation regarding fire management activities.

Goal 5. Develop and conduct a monitoring program with recommended standard monitoring levels commensurate with the scope of the fire management program, and use the information gained to continually evaluate and improve the fire management program.

Objectives:

- √ Monitor all fires >100 acres, using standard protocols, for severity, behavior and resources affected.
- √ Annually review and update information in the FMP based on monitoring data collected during wildland and prescribed fire events.

Goal 6. Support fire research and integrate knowledge gained through this and other research into future fire management decisions and actions.

Objectives:

- √ Identify and prioritize fire research needs and develop at least one funding proposal by 2008.
- √ Review current fire research annually and incorporate any new pertinent information during the annual review of the FMP.

Goal 7. Develop and maintain professional and technical expertise in all aspects of fire management.

Objectives:

- √ Provide annual refresher training for all red-carded employees, and facilitate their participation on wildland fire assignments, in order to maintain qualifications.
- √ Create and implement annual fire training and development plans for each interested employee.
- √ Annually update and train all staff regarding current and new fire operations and procedures.
- √ Plan and conduct all fire management activities in accordance with all applicable laws, policies, and regulations.

Goal 8. Reduce the potential for impacts to natural and cultural resources from suppression activities.

Objectives:

- √ Incorporate the MIT (see Appendix H, Part 11) into all suppression activities, to the greatest extent feasible and appropriate.
- √ By 2008, develop a resource advisor guide so that appropriate management responses and strategies are developed for site specific resource concerns in the Monument.
- √ Subsequent to the development of the resource advisor guide, for every wildfire event, identify and implement appropriate management responses and strategies that address site specific resource concerns.

Goal 9. Minimize direct, operational and indirect impacts to cultural resources as a result of fire management actions.

Objectives:

- √ For every planned and unplanned fire management action, implement, as appropriate, the mitigations in Appendix D.
- √ By 2008, complete a GIS database containing spatial information for all cultural resources in the Monument (archeological sites, structures, cultural landscapes, etc.) and make it available for fire management planning purposes.
- √ By 2010, alter fuel conditions in 50% of Developed Area FMU such that predicted flame lengths under extreme fire conditions will be less than four feet.

Goal 10. Improved the understanding of the role of aboriginal burning and other activities on the biotic communities of the Monument.

Objective:

- √ Seek funding for a comprehensive study, including literature searches, review of existing biological and anthropological data, and consultation with contemporary Native Americans.

Goal 11. Promote public understanding of fire management programs and objectives.

Objective:

- √ By 2008, Develop and implement the public fire information plan, and prevention plan, annually.

Goal 12: Monument staff and visitors are to be protected from unhealthy levels of air pollution from prescribed fires. Average visibility within the Monument will not be impaired to levels below the dirtiest 20th percentile as a result of prescribed fires.

Objective:

- √ Ambient concentrations of particulate matter (PM_{10}, $PM_{2.5}$), as measured at critical receptor sites, will not exceed national ambient air quality standards, as established by the US EPA.
- √ Visibility will not be allowed to degrade to levels within the worst 20th percentile, for more than four consecutive days.

2.2 MANAGEMENT CONSIDERATIONS

2.2.1 Sources of Authorities

Authority for resource management, including fire management, is found in the Organic Act [16 USC Sec. I, August 25, 1916], which states that the purpose of the NPS:

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

That the authority set forth in the Organic Act extends to all units of the National Park Service, including National Monuments, was clarified in the 1978 Redwoods Act, as amended. This act reasserted the system-wide standard of protection prescribed by Congress in the original Organic Act.

> "Congress further reaffirms, declares, and directs the promotion and regulation of the various areas of the National Park System...shall be consistent with and founded in the purpose established by the first section of the Act of August 25, 1916, to the common benefit of all the people of the United States. The authorization of activities shall be construed and

> the protection, management, and administration of these areas shall be conducted in light of the high public value and integrity of the National Park System and shall not be exercised in derogation of the values and purposes for which these various areas have been established, except as may have been or shall be directly and specifically provided by Congress."

The authority for emergency fire accounts is found in the following:

- Section 102 of the General Provisions of the Department of Interior's annual Appropriations Bill provides the authority under which appropriated monies can be expended or transferred to fund expenditures arising from the emergency prevention and suppression of wildfires
- 31 US Code 665(E)(1)(B) provides the authority to exceed appropriations due to wildland fire management activities involving the safety of human life and protection of property.

Authorities for procurement and administrative activities necessary to support wildfire incidents are contained in the Interagency Incident Business Management Handbook.

Authorities to enter into agreements with other Federal bureaus and agencies; with state, county, and municipal governments; and with private companies, groups, corporations, and individuals are cited in NPS-20 (Federal Assistance and Interagency Agreements). These include the Reciprocal Fire Protection Act of May 27, 1955 (42 USC 815a; 69Stat 66).

Authority for interagency agreements is found in "Interagency Agreement between the Bureau of Land Management, Bureau of Indian Affairs, National Park Service, US Fish and Wildlife Service of the United States Department of the Interior and the Forest Service of the United States Department of Agriculture" (1996).

Authority for rendering emergency fire or rescue assistance outside the National Park Service is the Act of August 8, 1953 (16 USC lb(l)) and the Departmental Manual (DM 910).

2.2.2 Legislative Conformance Considerations

The NPS is constrained from implementing fire management actions that do not comply with relevant federal laws, and regulations and executive orders of the President. Relevant to the NPS programs and the FMP are the NPS Organic Act, the enabling legislation establishing Pinnacles National Monument, NEPA, NHPA, the ESA, the Clean Water Act (CWA) and the Clean Air Act (CAA).

2.2.2.1 Enabling Legislation

Pinnacles National Monument was established by Presidential Proclamation in 1908 stating that "the natural formations, known as Pinnacles Rocks, with a series of caves underlying them…are of scientific interest, and it appears that the public interests would be promoted by reserving these formations and caves as a National Monument, with as much land as may be necessary for the proper protection thereof." Incorporated into the Monument were portions of the Pinnacles Forest Reserve, which had been established by Presidential Proclamation in 1906.

The current planning process to update the GMP for the Monument revisits the President's intentions in establishing the Monument and, through a public process, develops significance statements which hope to define the Monument's most unique and important resources. The draft significant statements name the unique geology of the area including the remnant volcano which was split between continental plates, the rare talus caves, the wilderness of central California's native ecosystems, and habitat values of the ecosystems. Other important resources are structures and infrastructures built during the Great Depression by the Civilian Conservation Corps and structures and artifacts associated with homesteading, ranching, Native American use and remnants of the early efforts to preserve the area as a national monument.

The EA prepared for the FMP assessed the potential of fire management actions to impact the resources and the visitor experience of the Monument. NPS Management Policies (NPS 2006, Section 1.4) require that additional attention be paid when assessing potential effects to an NPS unit's unique and most important resources and values, such as those named in the enabling legislation or listed as significant in the GMP. Unless directly and specifically provided for by legislation or by the proclamation that established the unit, the NPS is prohibited from implementing any actions that would impair or cause unacceptable impacts to significant resources. This level of assessment addressing impairment was performed for the FMP in the EA and the conclusion in the FONSI was that no significant resources would be unacceptable impacted or impaired as a result of FMP actions. This commitment to resource protection needs to be carried through to implementation by Monument staff.

California red-legged frog
by Marc Jennings

2.2.2.2 Endangered Species Act

The Endangered Species Act (ESA), as amended, (PL 93-205, 87 Stat. 884, 16 USC §1531 et seq.) protects threatened and endangered species from unauthorized take and directs federal agencies to ensure that their actions do not jeopardize the continued existence of such species. There are approximately 1,300 species that found entirely or in part in the USA and its water that are listed or proposed for listing as threatened or endangered under the ESA. Two of the wildlife species found in the Monument are listed as threatened or endangered under the ESA.

An assessment of the level of impact of FMP actions on these species was conducted for the FMP EA in consultation with the US Fish and Wildlife Service (FWS), the regulatory agency for the ESA. The FWS approved a series of mitigation measures that must be implemented for FMP actions in order to protect the red-legged frog and California condor. In signing the FONSI, the NPS adopted all the protective measures listed in Appendix D, including those recommended by the FWS to ensure that adverse effects to listed wildlife would be avoided. The record of the consultation conducted with the FWS for this FMP is in Appendix F. It is the responsibility of NPS staff to ensure that these measures are assigned to FMP projects when relevant and implemented as part of the project.

2.2.2.3 Clean Air Act

The Clean Air Act provides the primary authority for protecting and enhancing the nation's air quality. In 1977, Congress amended the Act to prevent the significant deterioration of air quality in clean air areas of the United States and to protect visibility in certain areas, including Pinnacles. Pinnacles NM is designated a Class I area. This is a mandatory designation, requiring the federal land manager to protect the air quality related values of the monument from air pollution impacts. Air quality related values include visibility, plants, animals, water quality, historic and cultural resources, and other resources that could be impacted by air pollution.

The NPS Air Quality Office and EPA established a monitoring station near the east entrance of the monument in 1987, and have completed an air clarity study. The monitoring station also continues to monitor particulate and ozone levels. Occasionally, foehn winds and persistent inversion layer draw air pollutants from the Santa Clara Valley into the monument. An encroaching urban landscape is steadily decreasing the distance between pollution sources and the monument, with a resulting trend towards declining air quality.

The Federal Government has ceded responsibility and authority to establish air quality standards and regulations to the states (RM #18, Chapter 14). Therefore, the Monument complies with the Clean Air Act by adhering to the requirements of the California Air Resources Board (CARB) and the Monterey Bay Unified Air Quality Control District (MBUAPCD). The MBUAPCD has primary responsibility for control of air pollution from prescribed burning and has established procedures that must be followed prior to implementation of a prescribed burn. These include the submittal of a Smoke Management Plan and Application for approval prior to conducting a prescribed burn. The specific requirements of the MBUAPCD are further detailed in Section 3.4.3 of this FMP.

2.2.2.4 National Historic Preservation Act (NHPA)

The NHPA (1966), as amended, requires agencies to take into account the effects of their actions on properties listed in or eligible for listing in the National Register of Historic Places. The Advisory Council on Historic Preservation has developed implementing regulations (36 CFR 800) that allow agencies to develop agreements for consideration of these historic properties. The NPS, in consultation with the California State Historic Preservation Officer (SHPO), developed a detailed Programmatic Agreement for implementing FMP projects based upon an existing draft Department of the Interior Fire Management Plan Programmatic Agreement. The requirements in the Programmatic Agreement are incorporated into the mitigation measures developed and adopted specifically for implementing FMP projects.

The California SHPO was provided with the FMP EA for review and comment. No comments were received and it was assumed that the mitigation measures in the EA were found to be adequate to protect the cultural resources of the Monument. These measures are listed as CUL-1 to CUL-17.

2.2.3 Policy Considerations

NPS regulations and policies are developed on a national level in NPS Management Policies (2006) and the NPS Director's Orders addressing specific topics for example Director's Orders 12 (regulations for implementing the National Environmental Policy Act), Director's Order 18 (regulations for Fire Management Programs), Director's Order 28 (management of cultural resources and conformance with the National Historic Preservation Act), and Director's Order 77 (natural resource management). (See Section 1.2.2 and 1.2.3 of this FMP for further discussion of NPS fire management policies). The Pacific West Regional Office generates policy guidance that applies to all national parks in the region. The Monument issues policy guidance through memos or "standard operating procedures" (SOPs) that only apply to the Monument and its staff.

The FMP EA was developed in conformance with NPS policy direction and the programmatic direction of the FMP, when converted into actual site-specific projects, would, in turn, conform to NPS policies with the caveat that the scope of the actions does not exceed those described and assessed in the FMP and that all relevant mitigation measures are implemented and regulatory requirements followed.

2.2.4 Jurisdictional Considerations

2.2.4.1 Direct Protection Areas (DPA)

The NPS is responsible for providing appropriate suppression of wildfires for lands within the Monument. Therefore, lands within the designated boundary of the Monument are Federal Responsibility Area or NPS-DPA. While the NPS has the financial responsibility for suppression, it lacks sufficient protection resources on site to accomplish the suppression (i.e., fire engines, handcrews, etc). NPS uses both formal and informal cooperative fire protection agreements with CDF, BLM and U.S. Forest Service to be able to provide initial attack and extended attack incident management and support for wildfire incidents in the Monument.

2.2.5 Technical or Logistic Considerations

2.2.5.1 Limited Season for Effective Use of Prescribed Burning

The normal weather window for prescribed burning at the Monument is roughly from December to April depending on the timing of seasonal rains. The MBUAPCD approves applications for certain types of prescribed burns from December 1 until April 30 unless there are special circumstances such as a compelling need to burn prior for ecological benefits such as burning an area prior to seed setting.

2.2.5.2 Risk-related Considerations

Management of natural ignitions for resource benefit (Wildland Fire Use for Resource Benefit) is not feasible for the Monument. Due to the unpredictable fire behavior and volatility of chaparral vegetation, high fuel loading around the perimeter of the Monument, the relatively small size of the Monument, it would not be possible to allow a fire to burn and keep the fire within the Monument boundaries. The Bear Gulch Reservoir should not be used as a water source for suppression efforts due to the presence of the California red-legged frog, a federally listed threatened species.

Limited access within the Monument is a serious consideration for controlling wildfires. There are only two access roads, one to the east side of the monument, and one to the west side of the monument. To the eastern entrance to the Monument from the Bear Valley Forest Fire Station on Highway 146 is approximately 30 minutes. The CDF Gonzales Forest Fire Station on Route 1 near Soledad State Prison has a response time of approximately 10 minutes to the Monument's western boundary. Control is further complicated by the lack of roads and very overall limited access within the Monument. Due to the rugged terrain, fire suppression MIT procedures may include allowing fires to burn to natural boundaries as well as the use of backfiring techniques, concentrating direct suppression in areas needed to protect lives and property.

Prescribed burning would not be an appropriate tool for hazard fuel reduction at the Monument as the risks to the natural resource are too high. The accumulation of hazard fuels in forested ecosystems, can lead to wildfires that burn hotter and faster. This is not the case in chaparral systems. Since the primary fuel in chaparral fires is the live shrubs, the accumulation of fuels in these habitats is not likely to increase the intensity or size of a fire (Moritz et al. 2004). Use of non-fire applications, such as hand and mechanical removal of hazardous fuels, would be the strategy of choice for creating defensible space around structures and alongside roads. Accumulated debris from mechanical fuel reduction could be reduced through chipping or pile burning.

2.2.5.3 Resources or Values Considerations

A total of 28 archeological sites have been recorded and numerous others, known to monument staff, await formal documentation. Twenty-five of these represent Native American occupations, while three are the remnants of homesteads settled in the late 19th or early 20th centuries. The historical sites include building foundations associated with other landscape modifications (rock walls, pits, fences), and trash scatters containing an array of artifacts (stoves, cans, glass, ceramics, ammunition, farm implements). None of these historical sites has been formally evaluated for National

Register significance as archeological resources. The primary concern is damage to these sites during fire-line construction and all known sites are mapped for consideration during fire management activities.

California condors and California red-legged frogs are federally listed species under the ESA that are found in the Monument. A primary concern for condors is the potential for collisions with aircraft and the disturbance of nesting activities by aircraft and other noise generating equipment. Maps of known nest sites, roosting areas and other locations of recent condor activity will be maintained by the Monument staff and made available during fire management activities to ensure that habitat areas are avoided and condors are not disturbed unless public and firefighter safety or private property are jeopardized. California red-legged frogs may be harmed by fire retardant, either by direct contact or through the contamination of ponds or streams or by dipping or pumping from water sources. Maps of red-legged frog habitat, ponds, reservoir, and streams will be maintained by Monument staff and made available during fire management activities to ensure that habitat areas are not disturbed unless public and firefighter safety or private property are jeopardized.

As the significance statements being drafted for the GMP update demonstrate, the Monument contains many significant and unique natural and cultural resource values. Values to be protected and their susceptibility to damage or loss by fire are discussed in more depth by FMU, in Section 2.4 of this FMP. Resource management objectives drive strategies with the objectives of restoring and maintaining the naturally functioning ecosystems, restoring cultural landscapes and protecting sensitive resources.

2.2.5.4 Staffing Considerations

The NPS has instituted new guidelines for prescribed burning (NPS 2006b, Chapter 10), which, among other changes, require that all NPS prescribed burns have “contingency resources” (such as fire trucks on stand-by) committed and assigned to every burn. These contingency resources must be available based on the upper limits of the prescription parameters. Resources may be requested from competing projects especially in the peak of the national fire season in the summer months when resources needed for prescribed burns are also needed for emergency fire suppression.

Wildland fires at the Monument are managed with the support of CDF, BLM, FWS and the US Forest Service. This interagency approach to wildland fire management involves partnership, cooperation and collaboration with CDF-San Benito-Monterey Unit; the BLM’s Hollister Field Office, the FWS San Luis National Wildlife Refuge Complex, Point Reyes National Seashore (PRNS) and the Los Padres National Forest. In addition, there are opportunities to become involved with the San Benito County and Monterey County Fire-Safe Councils.

Due to the lack of a full-time Fire Management Officer (FMO) at the Monument, technical assistance on fire management matters is shared between the BLM Hollister Field Office FMO and the PRNS FMO. This assistance will be in areas such as the Weather Information Management System (WIMS), the Wildland Fire Management Information (WFMI) System, the National Fire Danger Rating System (NFDRS), the

Resource Ordering System Status (ROSS), the Incident Qualification and Certification System (IQCS), Fire Program Analysis (FPA) budgeting.

The two agency FMOS will share workload by assisting the Monument staff with wildland fire qualification and certification programs, coordination of fire training and mobilizations, development of agreements with local and state agencies, administration of Rural Fire Assistance Program grants to local rural fire departments, fuel reduction activities, prescribed burning, and developing fire prevention, preparedness, and suppression operational plans.

2.3 WILDLAND FIRE MANAGEMENT OPTIONS

To accomplish FMP goals, wildfires will be suppressed, while taking into account resource objectives and sensitive resources to be protected. The Monument's fire and resource managers will balance potential resource impacts of wildfires with the potential impacts of fire suppression activities in choosing the Appropriate Management Response (AMR). The tenets of wildland fire management options at the Monument can be summarized as consisting of the following component strategies:

- The management of natural ignitions for resource benefits (Wildfire Use for Resource Benefit) will not be used.
- Prescribed fire will be used to achieve ecological benefits for the natural resources in the Monument or to promote the integrity of cultural landscapes.
- The principal objective of prescribed burning should not be to reduce large accumulations of hazardous fuels.
- The preferred management tool for reducing hazardous fuels accumulations will be by non-fire applications such as hand and mechanical methods.
- Mechanical fuel reduction projects will focus on creating a minimum of 100 feet of defensible space around structures and capital improvements, reducing roadside fuels to allow for proper clearance and reducing accumulations of invasive exotic plants acting as hazardous fuels.
- Mitigation measures addressing potential environmental impacts will be incorporated into site specific projects as assigned through interdisciplinary project review as required by the NEPA process completed for the FMP.
- In accordance with NPS policy, use of MIT in all fire management activities will be required (see Appendix H, Part 11). MIT specific to the appropriate to the resources of the Monument should be developed such as employing backfiring techniques in fire suppression, minimizing tree cutting and clearing of firelines, contain wildfires within natural fire breaks (e.g., roads and streams) whenever feasible and employ dye-free retardants to avoid impacts to rock formations.
- Develop a cadre of resource advisors (READs) and a READ guide so that staff trained on sensitive resources in the Monument can be available for fires within and adjacent to the Monument.

2.4 ENVIRONMENTAL FACTORS INFLUENCING FIRE MANAGEMENT

2.4.1 Fire History

2.4.1.1 Native American Influence

It is well documented that native Californians employed landscape burning, among other tools, to manipulate vegetation for economic, social, political and spiritual well-being (Lewis 1993). Less well-known, however, are the on-the-ground specifics regarding Native American burning, including seasonality, spatial extent and patterning, frequency, intensity and other variables. The voids in knowledge relate to a number of factors, including lack of interest among ethnographers studying native cultures and economic and political changes brought about by Euro-American colonization. In the case of the Costanoan, the principle ethnographic group that used the Pinnacles region, native lands and lifeways were forcibly or voluntarily abandoned for life in the newly established Spanish Missions in the late 1700s and early 1800s.

Based on limited documentary evidence and studies of contemporary cultures that still use fire as a management tool, however, some inferences regarding the possible role of aboriginal burning can be developed (Siefkin 2004). Specifically, the more intensively an area is used, the greater the frequency at which fire is applied and the more controlled the burn pattern. For example, fuels immediately surrounding villages are often burned on an annual basis to reduce the threat of wildfires and improve the yield and quality of important plant foods and basketry materials. Frequent fuels management in these areas probably reduces the contribution of natural fire to the local fire regime. Less intensively used areas tend to be fired less frequently and with less spatial control (e.g., improve habitat for large game), and it is in these areas where natural fire can play the greatest role.

The presence of Native Americans in the Monument is documented almost exclusively in the form of archeological remains, although the nature of occupation is poorly known. Available evidence does suggest, at least late in prehistory, that much of the Monument was primarily used on a temporary or seasonal basis for the purpose of resource extraction (e.g., collecting acorns and seeds, hunting deer). It is likely that these visits were made by inhabitants of villages in the adjacent Salinas and San Benito river valleys (west and east of the Monument, respectively).

The field notes of ethnographer J.P. Harrington document the use of over 150 plant species among the Costanoan for medicine, subsistence, manufacturing and other purposes (Bocek 1984), at least two-thirds of which are known to occur within the Monument. Importantly, a significant number of these taxa show positive responses to fire (e.g., increased growth, improved seed yield) (USDA, Forest Service 2004), and many are known to have been actively burned by native Californians (Lewis 1993; Anderson and Moratto 1996). For example, the understories of oak groves were lightly burned to facilitate the acorn harvest and reduce acorn-consuming pests like filbertworms, and grasslands were fired to improve yields of critical seed crops such as tarweed and redmaids. While accounts regarding Costanoan fire-use are mostly unspecific, it is likely burning was conducted for reasons similar to those of other tribal groups for whom more information is available.

Keeley (2002) suggested that Native Americans burned the vegetation of the southern and central California coast ranges with the intent of increasing the diversity, quantity and productivity of important resources, including plants, animals and water, reducing the threat of catastrophic wildfires, eliminating hiding places for predators and human enemies, and facilitating travel. Specifically, he hypothesized that Native American burning subsidized the low occurrence of natural lightening in the region as an ignition source, and that landscape patterns of grassland and open shrubland were significantly increased at the expense of dense shrubland. This was accomplished by firing shrublands at an interval (<10-20 years) that was too short to allow regeneration of most shrubs and favored herbaceous vegetation.

If correct, this would be potentially significant in that chaparral is today the dominant vegetation community in the Monument. Recognizing the near absence of historical documentation for shrubland burning, however, Keeley (2002) acknowledged that it would be difficult to determine how much of a given landscape was so altered by Native American burning, and that native burning may have been less prevalent (and thus chaparral more abundant) in areas of rugged and remote terrain like that comprising most of the Monument.

Anthropological studies conducted in the Santa Monica Mountains of southern California, an area with broadly similar vegetation to the Monument, suggest that complex mosaic of vegetation communities in various stages of succession may have been the aim of Native American inhabitants. For example, based on ecological data, historical documentation and an examination of botanical remains from archeological sites, Hammett (1991) suggested that area Native American groups practiced a “fire-follower” adaptation, targeting the diverse array of herbaceous species available for several years in burned shrublands. She further speculated that by burning small patches of shrubland, groups could maintain maximum biodiversity with shifting mosaics of patches in varying stages of succession. Such conditions could be attained by burning at an interval intermediate between that needed to permanently type convert shrublands to grassland (<10-20 years) and natural fire occurrence (40-100 years). King (1993, 2000) noted that many of the staple plant foods in the Santa Monica Mountains required pre-cooking to improve their edibility (e.g., acorn, hollyleaf cherry, soap plant, yucca [not native to the Monument]), and thus, access to substantial amounts of firewood. Several species of chaparral were identified as carbonized firewood in archeological cooking features, leading King to speculate that groups created and/or maintained stands of live and dead chaparral in proximity to villages and processing sites. He also suggested that measures may have been taken to fire-guard firewood stands from wildfires.

While it remains unclear to what extent Native American burning shaped vegetation in the Monument, it is probably safe to conclude that those areas most frequently used by Native Americans (e.g., oak woodlands and grasslands in low gradient topography) were also subject to the most frequent burning. It is these same communities that were most heavily impacted by subsequent Euro-American ranching activities (e.g., burning, grazing) and conform to the Adaptive Management Areas identified in the preferred alternative of this plan that will be intensively treated with prescribed fire and mechanical means to restore native herbaceous cover. If chaparral was a significant

component of the pre-contact vegetation in the Monument, and the fire regime was, as noted, characterized by large and infrequent fires, Native American inhabitants of the Monument and surrounding areas presumably compensated through early season burning around habitation sites and resource extraction locations, as practiced by contemporary non-industrial peoples in highly flammable Australia and the boreal forests of Canada (Lewis 1989; Lewis and Ferguson 1999).

A fire history study by Greenlee and Moldenke (1982) included all of San Benito and portions of Monterey and Fresno counties in the Diablo and Gabilan Ranges. Evidence from fire scars, research reports, news articles, interviews, and fire records was used to construct a fire history and examine return intervals. The study concluded that evidence from the current pattern of lightning ignitions indicates that pre-human lightning fires were probably infrequent, upper-slope, fall fires. Depending on the type of vegetation that existed at the time, these fires were probably large. Today, a potential for large lightning fires exists with the present chamise cover.

Additional research is likely to yield evidence of Native American influence on the vegetation of the Monument. Among the potential areas of study include further analysis of historical documents, identification of botanical remains from archeological contexts and surveys of living vegetation in proximity to archeological habitation sites.

2.4.1.2 Post-settlement Fire History

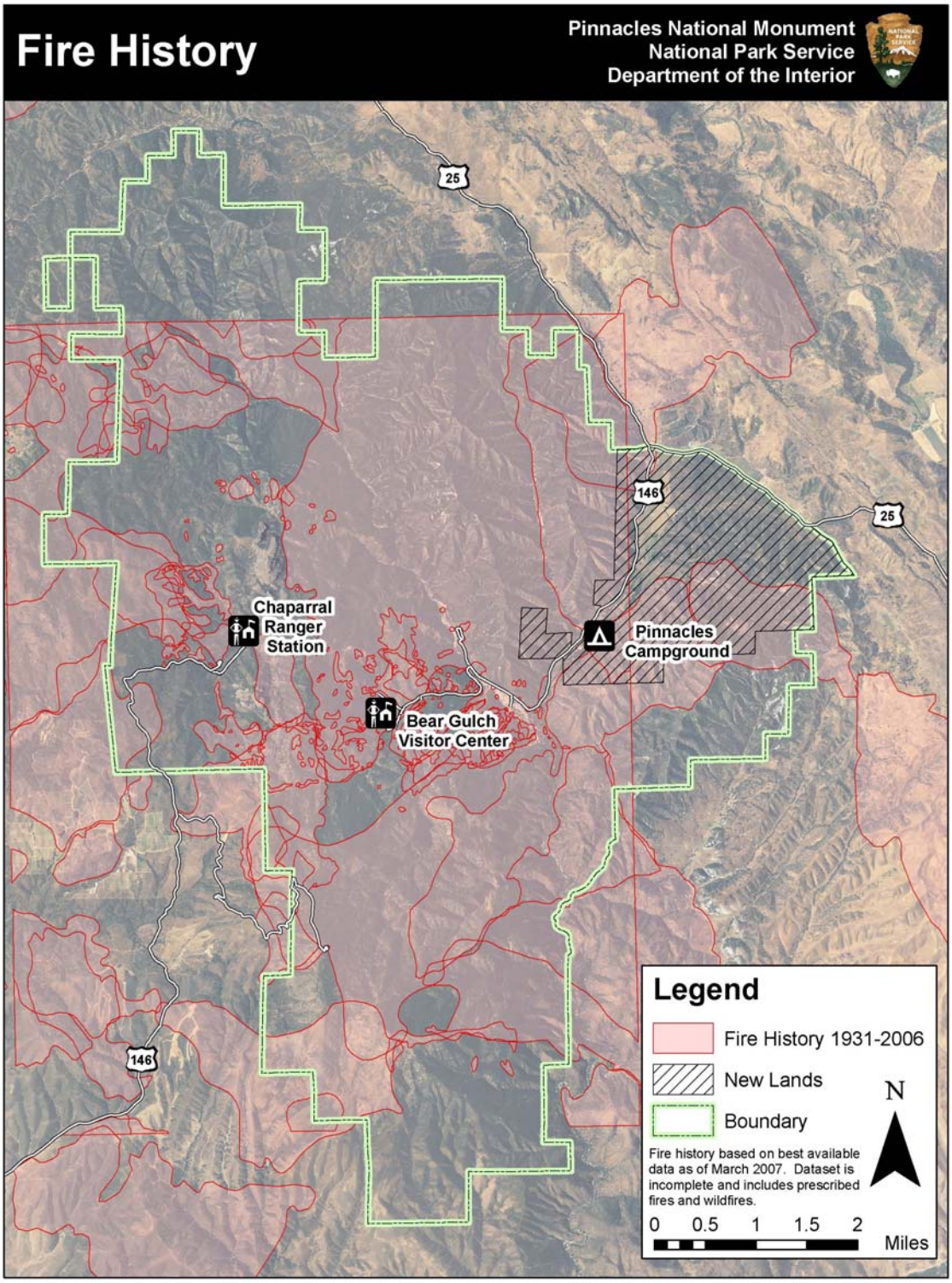
The extensive fire history compiled by Greenlee and Moldenke (1982) on the Diablo and Gabilan Mountains began looking at the natural fire return intervals in the region. Unfortunately, some of the only trees available for dating were gray pines, which are short-lived and could only provide insight into the fire history and fire return intervals for the last 100 years. Most of this period is influenced by the protections and projects that occurred after the area became a National Monument in1908.

Little of the research conducted supports the idea that fire suppression had a significant effect on the natural fire regime in the Monument. In all, more than 30 fires of various acreages have been documented in the Monument over the past 80 years.

The 1982 Greenlee and Moldenke fire history research found an average of one large fire (>2500 acres) every nine years and a reported fire return interval of 40 years. They identified approximately 146 lightning fires that had occurred in and around the Monument between 1929 and 1978. Though there was little information on the largest fires, it appeared that 3 historic fires burned all or part of the Monument in 1877, 1900 and 1931. In the past fifty years, fires have repeatedly burned most of the Pinnacles (see Figure 2, Fire History). A study of fire scarred trees in the Monument found scars dating back to the 1900 fire throughout the Monument, indicating that this fire was very widespread, covering nearly the entire Monument. Because of this research, the 1900 date is used as a likely baseline for most of the vegetation in the Monument (Greenlee and Moldenke 1982).

The scattered and infrequent natural ignition pattern suggests that large fires burned mainly into the Monument from outside the boundary. There is only one definite

Figure 2 – Fire History, Pinnacles National Monument



lightning fire recorded for the Pinnacles area since 1934. However, it is uncertain how frequently the Pinnacles area burned from lightning fires in the distant past because some lightning fires ignited from great distances may have spread miles reaching the Monument during the long, dry summer (Agee and Biswell 1970) The fire record shows that the majority of recent fires were human caused. This is the general situation for most chaparral fires in southern California (Agee and Biswell 1970). More than one third of the fires burned in September, with substantial percentages also occurring during June and July.

2.4.1.3 Recent Fire History

Since the establishment of the Pinnacles National Monument, suppression has been the standard protocol for dealing with fire. Efforts were made in the 1970s, 1980s, and 1990s to use fire as a tool to create buffer zones around the developed areas and to "reintroduce" fire into the ecosystem (GMP). This was based on the hypothesis that fire had been excluded from the ecosystem, due to the Monument's establishment and subsequent suppression efforts. The approach was documented in the 1970 GMP, 1986 FMP, and the 1999 RMP, and has driven the direction of fire management in the Monument until recently. These documents state that a successful fire management strategy "has resulted in an unnaturally dense and over-mature vegetative cover over most of the park."

The volatile nature of the vegetation in the Monument, however, meant that many, if not all, of these "successful" suppression efforts were actually ineffective at stopping the spread and intensity of fires. This is supported by observations of suppression efforts during the last three large fires (1994, 1995, and 1998) and by the fire history of the Monument that recorded substantial large fires during the last 100 years (Greenlee and Moldenke 1982) (see Figure 3, Large Fires).

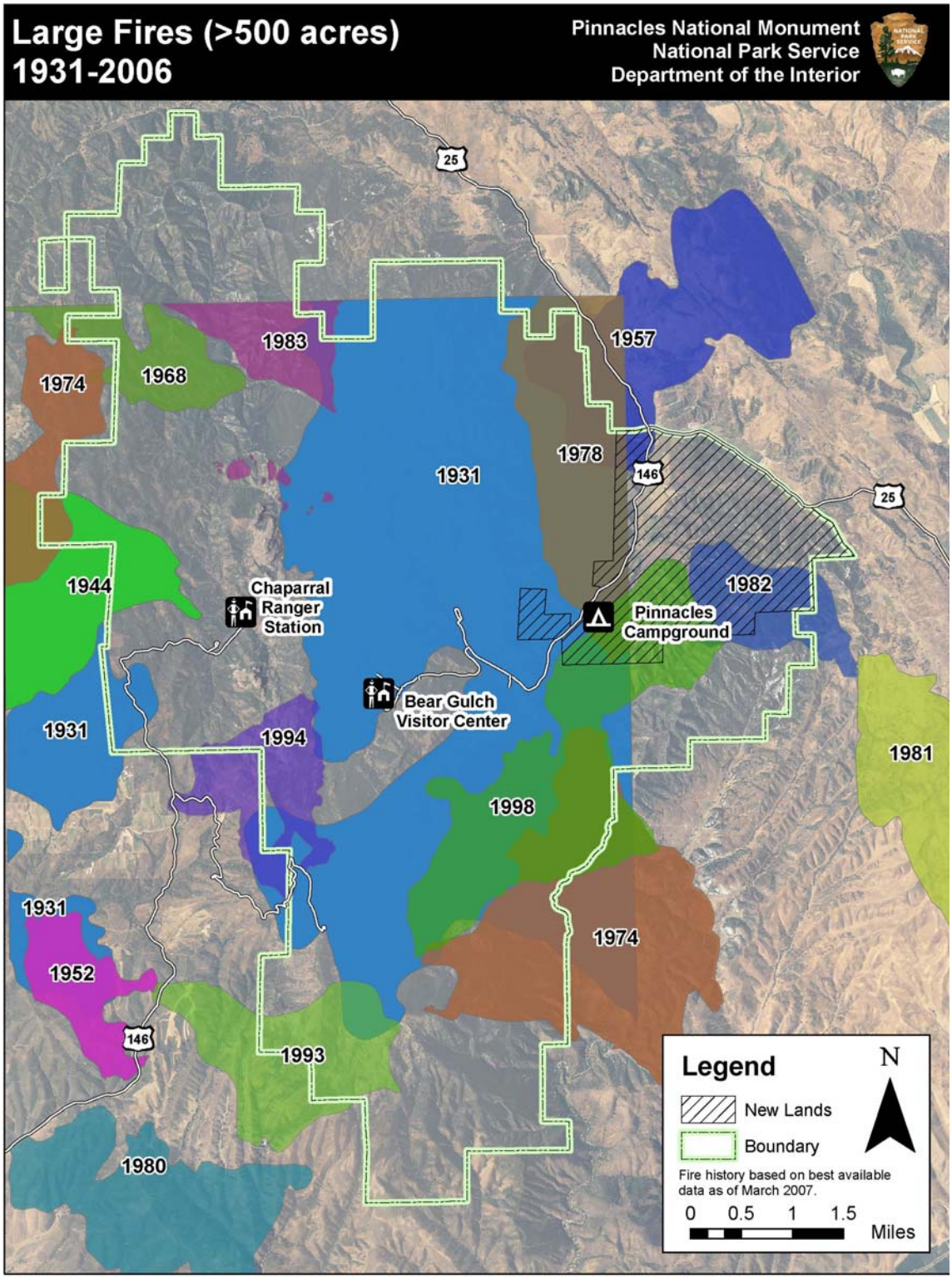
Table 1 – Acreages/Number of Fires Annually, 1931 - 2001

Year	Prescribed Burns, #	Wildfires, #	Fires, All Types	Acres All Types	Acres Prescribed Burns	Acres Wildfires
1931	0	3	3	12,050.81	0	12050.81
1934	0	1	1	0.92	0	0.92
1935	0	1	1	0.72	0	0.72
1936	0	1	1	1.22	0	1.22
1938	0	1	1	7.10	0	7.10
1939	0	1	1	1.00	0	1.00
1940	0	1	1	103.51	0	103.51
1941	0	3	3	458.11	0	458.11
1944	0	1	1	516.96	0	516.96
1946	0	1	1	43.34	0	43.34
1947	0	3	3	59.53	0	59.53
1949	0	1	1	1.21	0	1.21
1951	0	1	1	1.26	0	1.26
1952	0	1	1	0.56	0	0.56

Year	Prescribed Burns, #	Wildfires, #	Fires, All Types	Acres All Types	Acres Prescribed Burns	Acres Wildfires
1953	0	1	1	122.79	0	122.79
1954	0	1	1	1.09	0	1.09
1957	0	3	3	855.12	0	855.12
1958	0	1	1	0.94	0	0.94
1959	0	1	1	0.38	0	0.38
1965	0	1	1	10.18	0	10.18
1967	0	1	1	0.57	0	0.57
1968	0	2	2	766.77	0	766.77
1969	0	1	1	0.40	0	0.40
1970	0	1	1	115.25	0	115.25
1971	0	1	1	87.94	0	87.94
1973	0	1	1	201.02	0	201.02
1974	0	5	5	3245.51	0	3245.51
1975	0	1	1	3.24	0	3.24
1976	0	1	1	36.75	0	36.75
1977	0	15	15	96.14	0	96.14
1978	0	1	1	1555.46	0	1555.46
1979	0	27	27	466.87	0	466.87
1980	26	2	28	567.03	294.90	272.13
1981	24	1	25	4,396.92	4,061.00	335.92
1982	8	3	11	2,878.27	1,127.00	1,751.27
1983	0	1	1	635.41	0	635.41
1986	1	0	1	2.00	2.00	0
1987	1	0	1	2.50	2.50	0
1988	0	0	0	0	0	0
1989	0	1	1	0.10	0	0.10
1991	0	2	2	4.10	0	4.10
1992	0	1	1	0.10	0	0.10
1993	0	2	2	661.38	0	661.38
1994	0	1	1	545.68	0	545.68
1996	1	1	2	0.30	0.10	0.20
1997	1	1	2	35.80	32.00	3.80
1998	0	1	1	2,797.00	0	2,797.00
1999	1	0	1	8.00	8.00	0
2001	0	2	2	15.10	0	15.10

A list of numbers of fires and acres burned is found in Table 1, compiled as a part of the PCHA -Fire Program Analysis, process in 2006. The largest wildfire in the past decade occurred in 1998 (See Figure 3, Large Fires). The Stonewall Fire started in early August due to arching power lines and burned a total of 642 acres within the Monument, 455 acres of BLM administered lands and 700 acres of private lands.

Figure 3 – Locations of Large Files, Pinnacles National Monument



There is a history of controlled burning in and near Pinnacles dating back to the 1950s, through the CDF, BLM, and the San Benito County Range Improvement Association. A minimum of 55 controlled burns were conducted from 1951-1979. Since 1979, the BLM, CDF, or private landowners, in cooperation with the NPS, conducted at least five prescribed burns near the north, east, and south borders of the monument. A prescribed experimental burning program was begun in 1976. From 1977 to 1982, a total of 1,458 acres were burned with roughly 50% in mixed chaparral vegetation.

The largest prescribed fire since the active period of 1980-82 was the Vineyard Prescribed Burn which was 32 acres in 1997 conducted to reduce fuel loading in brush vegetation. But for the past two decades, there has been little or no prescribed fire activity in the Monument due to lack of staffing, administrative constraints and the lack of a clear set of objectives for prescribed burning.

Fire has been used extensively in the Developed Area in the past to create “buffer zones” around the headquarters area. Prescribed burning for several years behind the headquarters area is thought to have resulted in the replacement of chaparral vegetation by non-native grasses – a condition that persists in some of this area up to the present.

Wildfires and prescribed burning has resulted in vegetation changes on the perimeter of the Monument. Three wildfires -- the Highway 25 Fire in 1978, the Romo Fire in 1974, and the Stonewall fire in 1998 – caused a near-continuous vegetation age-class shift along the Monument’s east boundary. Nearly three quarters of the northern boundary of the Monument has been burned in prescribed fires or wildfires since the 1970s. A portion of the south boundary was burned in the South Pinnacles Prescribed Burn in 1979.

2.4.1.4 Fire Regime

The Greenlee and Moldenke (1982) study concluded that evidence from current patterns of lightning ignitions indicated that naturally occurring lightning fires were probably infrequent, typically in the upper-slope and occurred in fall. Depending on the type of vegetation that existed at the time, these fires were probably large. Today, a potential for large lightning fires exists with the present chamise cover. The Greenlee and Moldenke research found an average of one large fire (>2500 acres) every nine years and a reported fire return interval of 40 years.

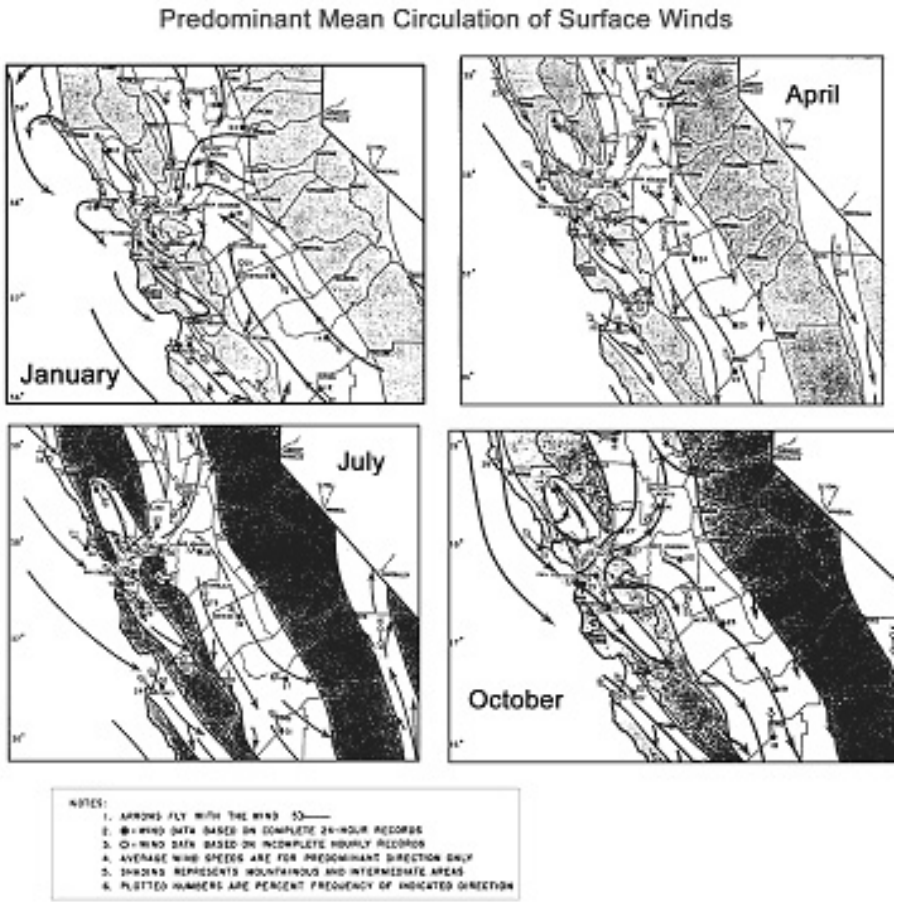
2.4.2 Climatic and Topographic Influences

2.4.2.1 Climate

The Monument has a Mediterranean climate typical along the coast of California, with cool, wet winters and hot, dry summers. Summer temperatures of over 100 degrees are common, but coastal fog will often come into the valleys at night. Nighttime summer temperatures of 50 degrees are also common, making for enormous fluctuations in daily temperatures. Winter climate is akin to the California deserts, with mild days and cold nights, with temperatures dropping into the low 20’s. Average precipitation is approximately 16 inches per year and is limited by the rain shadow of the taller Santa

Lucia Range to the west. The majority of rainfall occurs from December to March. Snowfall is rare, but does occur in significant amounts about every 10 years.

Figure 4 – Predominant Wind Patterns in Central California



Source: Bell 1958

The great variability in seasonal precipitation is due to the east Pacific high. This dominant weather feature shifts northward in the summer to shunt storms far to the north. Occasionally, this feature brings subtropical moisture into central California from southerly latitudes, producing 1-5 thundershowers per year in the Monument. Mostly, however, the east Pacific high acts as a giant valve completely shutting off precipitation for long stretches during the year. The east Pacific high shifts on approximately a 6-year cycle. The result is persistent drought for 5-8 years, followed by a wet period. Such cyclic variation is an important consideration in vegetation, wildlife, and water management.

The typical northwest wind of summer is reinforced by the dynamics of the thermal low-pressure area located over the Central Valley and the southeastern desert area. When wind patterns shift from the prevailing pattern in the summer, winds can flow out of the Great Basin into the Central Valley, the Southeastern Desert Basin, and the South Coast. The result is high pressure over Nevada and lower pressure along the central California coast. The lower coastal pressure causes the hot interior air to be rapidly drawn to the west from the hot, dry interior. The winds are dry, strong, and gusty, sometimes exceeding 60 miles per hour, particularly near the mouths of canyons oriented along the direction of airflow. These interior winds, primarily from the east in the vicinity of the Monument, are known as Diablo winds in the San Francisco Bay Area and Santa Ana winds in southern California (National Weather Service, 2007).

Figure 4 illustrates the predominant wind patterns in central California (Bell 1958). In the winter, the regional surface winds blow from the north-northeast. During spring and summer, stronger north-northwest winds dominate. These northwesterly winds are primarily caused and/or strengthened by the combination of high pressure offshore and the warmer air inland. During the fall transition, when warm easterly winds break through to the coast while inland conditions remain hot and dry, the coastal region faces its most significant fire threat.

2.4.2.2 Recurrent Drought

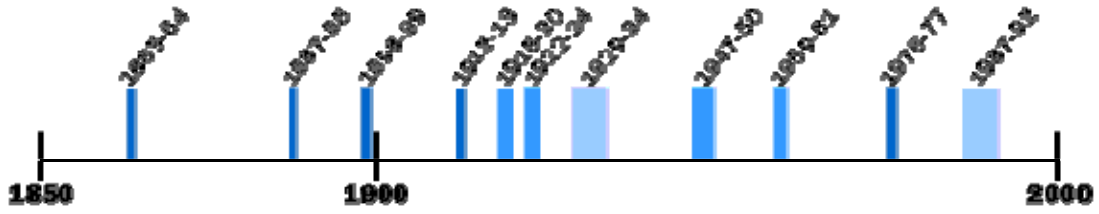
One dry year does not normally constitute a drought in California. Droughts occur slowly, over a multiyear period. There is no universal definition of when a drought begins or ends. Areas most reliant on annual rainfall typically feel impacts of drought first.

Droughts exceeding three years are relatively rare in northern California, the source of much of the state's developed water supply. The 1929-1934 drought years established the criteria commonly used in designing storage capacity and yield of large northern California reservoirs. Figure 5 compares the 1929-1934 droughts in the Sacramento and San Joaquin valleys to the 1976-1977 and 1987-1992 droughts. The driest single year of California's measured hydrologic record was 1977. California's most recent multiyear drought was 1987-1992.

Measured hydrologic data for droughts prior to 1900 are minimal. Multiyear dry periods in the second half of the 19th century can be qualitatively identified from the limited records available combined with historical accounts, as illustrated in Figure 5, but the severity of the dry periods cannot be directly quantified.

California sustained two epic drought periods, extending over more than three centuries. The first epic drought lasted more than two centuries before the year 1112; the second drought lasted more than 140 years before 1350. Studies of epic droughts evaluated drowned tree stumps rooted in Mono Lake, Tenaya Lake, West Walker River, and Osgood Swamp in the central Sierra Nevada. These investigations indicate that California has been subject to droughts more severe and more prolonged than those evidenced by the brief historical record.

Figure 5 – California's Historical Dry Periods, 1850-Present



Notes:

1. Dry periods prior to 1900 estimated from limited data.

2. Covers dry periods of statewide or major regional extent.

2.4.2.3 El Niño and La Niña

Under "normal" circumstances over the Pacific Ocean, trade winds rush toward the equator to replace rising sun-heated air and cause an upwelling of air off Peru. These winds are pushed farther west by a high-pressure zone over Tahiti and attracted by a low-pressure zone over northern Australia. During an El Niño episode, the situation is reversed, with a low over Tahiti and a high over Australia. The trade winds die, the upwelling stops, and the ocean surface warms up in the eastern Pacific. The jet stream over the North Pacific, which normally brings storms to Oregon, Washington, and British Columbia, moves south, picking up warmth from the warm-water bulge below, and deluges California (Gilliam 2002).

During severe El Niño episodes like 1982-1983 and 1997-1998, areas in central California received more than twice its "normal" rainfall. Houses were destroyed by mudslides, bridges were washed out, and highways were blocked. Although El Niño events occur every four to seven years, they vary greatly in timing and strength. A mild El Niño will scarcely have any important effect, but a strong one can bring disaster. The outlook for El Niño episodes in the 21st century is uncertain. As global warming continues, increasing temperatures of both the air and the water, El Niño events may increase in frequency and intensity (Gilliam 2002).

The opposite of El Niño is the less well-known La Niña. La Niña occurs when trade winds are stronger than usual over the Pacific Ocean, pushing more sun-warmed surface waters westward, causing more upwelling off Peru, and further intensifying the oceanic currents of the northern Pacific Ocean (Gilliam 2002). The wintertime effect of La Niña in central California is likely to be colder, windier weather and perhaps abnormal rainfall in either direction, too much or too little (and sometimes neither), depending on the erratic location of the jet stream. If La Niña persists into the summer, stronger upwelling off the California coast brings more fog to the area (Gilliam 2002).

2.4.2.4 Climate Change

Climate has changed over the millennia (e.g., the "Little Ice Age" from 1300-1800 AD), and will continue to change. For example, the amount of fog in the San Francisco Bay Area seems to have increased from 1885 to 1970 (Verran 1982). Unfortunately, after 1970, these data were no longer taken. Climatic change, caused to some degree by human actions, can have an important influence on the human environment, in part by altering the occurrence of wildfires. It is thought that the influence of human activities upon climate began at least 8,000 years ago with the advent of the agricultural revolution (Ruddiman 2003).

Surface temperature measurements recorded daily at hundreds of locations for more than 100 years indicate that the Earth's surface has warmed by about 1 degree Fahrenheit in the past century. This warming has been particularly strong during the last 20 years, and has been accompanied by retreating glaciers, thinning arctic ice, rising sea levels, lengthening of growing seasons for some, and earlier arrival of migratory birds (Union of Concerned Scientists 2004).

In California, average surface temperatures have increased 0.7 to 3.0 degrees Fahrenheit in the past century. The 20th century's ten warmest years all occurred in the last 15 years of the century. Seventeen of the eighteen warmest years in the 20th century occurred since 1980. In 1998, the global temperature set a new record, exceeding that of the previous record year, 1997 (Hannah et al. 2002). Air temperature has increased over the past 90 years, more so in large cities than in rural areas. Large urban areas are generally warmer than rural areas, and can have temperatures up to 5 degrees Fahrenheit higher, creating their own weather belt. This can be due to the removal of vegetation and trees, the presence of buildings and streets (which reflect heat stored in pavement), and the production of heat by human activities.

Along the California coast, sea levels will likely continue to rise. Depending on the climate model, they could rise at a rate similar to the historical rate (about 7 inches per century) or almost four times faster (Union of Concerned Scientists 2004). Differences in sea level rise along the coast can occur because of local geological forces, such as land subsidence and plate tectonic activity. The rise in sea level may be associated with increasing global temperatures. Based on results from modeling, warming of the ocean water will cause a greater volume of seawater because of thermal expansion. This is expected to contribute the largest share of sea level rise, followed by melting of mountain glaciers and ice caps (IPCC 2001). The impact of a rise in sea level on coastal areas will be amplified by any increases in the frequency and/or intensity of major storms.

Winters in the San Francisco Bay Area, for example, may become warmer, windier and wetter during the next century (Fried et al. 2003, Union of Concerned Scientists 2004). Summers may well become warmer, though winter will become proportionally even warmer. El Niños may increase in intensity and/or frequency.

Changes in the timing or amount of precipitation over the next century are likely to have a greater impact than changes in temperature (Union of Concerned Scientists 2004). For example, increases in the amount of winter rains could intensify flooding and landslide hazards. The suitable range will inevitably shift for each mix of plants and animals. Some of these changes are already occurring, providing a first glimpse of the processes and problems ahead. For example, the Edith's Checkerspot (a species of butterfly) is shifting from the southern to the northern limits of its range and from low-elevation to high-elevation sites, a likely consequence of rising temperatures. Other shifts are likely in the future, e.g., expanding grasslands will likely encroach on the foothill shrublands of the coastal ranges. In many cases, however, plant and animal species will not be able to shift northward or upslope because the potential habitat has been claimed by development or nonnative species, or contains unsuitable soils or other physical limitations.

A large proportion of change will occur in the frequency and/or intensity of extreme weather events such as severe storms, winds, droughts, and frosts. Similarly, the frequency and/or magnitude of some ecologically important processes such as wildfires, floods, and disease and pest outbreaks will likely change. Fried et al. (2003) predict that these conditions will produce more intense, faster-spreading fires in most locations. Their model shows that, despite any enhancement of fire suppression efforts, the

number of escaped fires (those exceeding initial containment limits) increased 51% in the San Francisco Bay Area. Area burned by contained fires could increase by 41%. Furthermore, Fried et al. (2003) predicted that fire return intervals in grass and brush vegetation types would be cut in half on average. Their reported estimates represent a minimum expected change, or best-case forecast. In addition to the increased suppression costs and economic damages, changes in fire severity of this magnitude would have widespread impacts on vegetation distribution, ecological condition, and carbon storage, and would greatly increase the risk to property, natural resources, and human life.

2.4.2.5 Topography

The Monument is located at the southern end of a short mountain range called the Gabilan Mountains. Beginning near Fremont Peak in the north, the rounded ridgeline connects several 3,000 foot mountains, ending at North and South Chalone peaks in the south. The Gabilan Mountain Range is part of the inner Coast Ranges, and is a small sub-range of the Diablo Range, located east of the Monument. The relief is variable with elevations ranging from 800 feet in the southeast corner, to 3,305 feet on North Chalone Peak in the southwest corner. Most of the Monument's topography is steep, with rolling hills away from the central ridgeline and at the periphery of the monument. The "Pinnacles" at the center of the Monument are the exposed weathered remnant of an ancient volcano.

2.4.2.6 Geology

The pinnacles are the remnants of a Miocene volcano that is in an advanced stage of decomposition. The action of erosion and the work of water and wind on these pyroclastics have given rise to the unusual and scenic effects for which Pinnacles is famous. Recent faulting and erosion have also sculpted the rock layers into vertical cliffs and spires sometimes several hundred feet high.

Located near the boundary of the Pacific Plate and the North American Plate, the geology of the Monument is an excellent example of the results of tectonic plate movement. The Pinnacles are believed to have originated in the Neenach Volcano, near present-day Lancaster, California. The displacement of the Pinnacles from its point of origin is a testament to the longevity and importance of the San Andreas Fault, which once split the original volcano. The right lateral movement of this giant transform fault has carried the Pinnacles north at a rate of approximately 1.5 inches per year.

Three large faults (Miner's Gulch, Pinnacles, Chalone Creek) occur within the area of the Monument, besides a number of smaller faults and fractures. A history of faulting and earthquakes has created deep, narrow gorges where huge boulders have toppled from higher formations. These boulders, wedged at various heights above the canyon floors, create the Bear Gulch and Balconies talus caves.

Seismic activity continues to be monitored by the United States Geological Survey (USGS). There is a seismometer along the Chalone Creek Fault and a corresponding seismograph in the Bear Gulch Visitor Center, which provides a continuous record of seismic activity. This continued monitoring will provide information about earthquake

phenomena along the San Andreas Fault, and provides the monument staff with data to illustrate and interpret the natural processes still shaping the Pinnacles area.

2.4.2.7 Soils

The soils in the Monument are typically thin, undeveloped sandy loams with large amounts of gravel and little ability to retain nutrients and water. Nutrient supply is low but well balanced. Small areas of soil are rich in hummus but average only two feet in depth. Soils offer little resistance to root growth, thus allowing extensive root development. These properties tend to increase moisture loss from the soil, causing less water to be available for plant cover. When plant cover is disturbed, soils become acutely susceptible to erosion during periods of intense rainfall.

2.4.3 Fire Weather

Local weather and the topography of the Monument interact to affect fire behavior. The area is subject to afternoon sea breezes which blow with a force roughly proportional to the temperature gradient between the cool air over the Pacific Ocean and the heated air over the land. The sea breeze is increased by air flow from the North Pacific High into the Central Valley Thermal Low and peaks during the height of the summer fire season. The breeze reaches Pinnacles between 1100 and 1400 hours each day, arriving at different times and from different directions, depending on how it is modified by local topography. The sea breeze interacts with complex topography and normal upslope and upvalley winds, causing frequent midday wind shifts and eddies at the junction of drainages. These winds result in unpredictable fire behavior, contributing to the formation of fire whorls and associated spotting problems.

The sea breeze approaches the Monument from the Salinas Valley. This process begins around mid-day and ends close to sunset. It combines with normal upslope flow to produce upslope winds on the west side of the Monument from mid-morning to late afternoon. The sea breeze progresses gradually inland, generally reaching its greatest penetration near the time of maximum temperature. These winds divert over and around major landforms of the Monument. Chalone Creek channels the flow from the Salinas Valley. The sea breeze blows up Chalone Creek during mid-morning and continues downstream, through the water gap between Machete Ridge and the Balconies. The sea breeze will then surface on the east side in the afternoon hours. The land breeze is a nighttime reversal of the diurnal sea breeze. This more westerly flow approaches the Monument through Bear Gulch. This land breeze overrides normal upslope winds, producing downslope winds in many locations on the east side of the Monument. This down canyon flow tends to be more gentle then daytime wind conditions

When the marine layer remains stationary along the coast on hot days, the sea breeze can penetrate up to 100 miles inland, with no appreciable cooling or increase in relative humidity. The sea breeze moderates fire weather when a deep layer of marine air accompanies it, particularly in the fall and spring.

Four synoptic weather patterns cause high fire danger at Pinnacles.

1. Heat wave conditions can occur when a subtropical high settles over California.
2. A high fire danger pattern can occur when a trough moves inland followed by high pressure along the coast. The flow of marine air is blocked as a result, temperatures are high, and relative humidities are low.
3. Frontal passage can produce shifting winds and dry northerlies after passage in the summer and fall.
4. Subsidence from the Great Basin High during the summer and fall, produces foehn winds surfacing on the western slope of the Sierra Nevada. These winds do surface at lower elevations at Pinnacles and can be felt on peaks and ridgetops. Influence of foehn winds at Pinnacles should not be underestimated, even though they do not create the explosive, uncontrollable fires associated with Santa Ana conditions in southern California.

2.6 FIRE MANAGEMENT UNITS (FMU)

An FMU is any land management area that can be defined by management goals and constraints, topographic features, access corridors, values at risk or values to be protected, political boundaries, fuel types, or major fire regime groups that set it apart from management characteristics of an adjacent unit. FMUs provide the framework for development of a wildland fire program. As directed by NPS Reference Manual #18 (NPS 2006b), each FMU should be unique as evidenced by management strategies, objectives, and attributes; should be consistent with management goals and objectives found in land and resource management planning documents; should avoid redundancy and should be kept to a minimum.

In developing the FMUs for the FMP, staff considered FMP goals, extent of designated wilderness, watershed limits, distribution of the Monument's improvements, roads and facilities, location of cultural resources. The Monument was divided into three FMUs (see Figure 6):

- Developed Area FMU: (376 acres and less than 2% of the Monument) is sited along the eastern and western entranceways and includes roadways, structures, paved walkways, maintenance facilities and picnic areas.
- Adaptive Management FMU: (203 acres and less than 1% of the Monument) Lands in this FMU support large populations of invasive exotic species that the Monument intends to control through the use of prescribed fire among other methods.
- Wilderness Areas (23,505 acres and 97% of the Monument): includes all areas of the Monument greater than 50 meters from paved roads, and 100 meters from buildings and structures but not in the Adaptive Management FMU.

The three FMUs differ by setting, fire management and resource benefit objectives, and fire management strategies to be employed.

2.6.1 Developed Areas FMU

The Developed Areas FMU includes all areas within 50 meters of paved roads and within 100 meters of structures or capital improvements in the Monument. The main components of this unit are the Bear Gulch Headquarters area, the Chalone housing and maintenance area, the Chaparral Ranger Station and picnic area, the proposed Westside development area, and the paved roads. These lands have been significantly altered by the placement of structures and are not considered natural lands for planning purposes.

The developed area is found primarily within the riparian vegetation area, near seasonal or perennial water sources. Since 80% of the Monument is dominated by chaparral, it follows that most of the developed areas are surrounded by chamise and California mixed chaparral at various stages of succession. Many of the structures found in the developed area were constructed by the California Conservation Corps in the 1930s and are significant cultural resources. Some historic trails can also be found in the developed area.

2.6.2 Adaptive Management FMU

The Adaptive Management FMU is made up of several parcels scattered throughout the Monument. These areas contain high concentrations of invasive exotic species that the Monument intends to control through the use of prescribed fire or mechanical treatments (*e.g.* mowing and weed whacking). In addition, this zone may be used for research burning, in order to learn more about fire effects on the vegetation of the Monument. These areas may be treated intensely for several years, and then left unburned until natural fires burn through the area.

Mechanical treatments (*e.g.* weed whacking) may also be used in the Adaptive Management Area to remove the accumulations of invasive exotic plant species acting as hazard fuels. Hazard fuel reduction reduces the threat of catastrophic wildfire, and reduces the risk of negative effects to Monument resources in the event of a wildfire. Hazard fuel reduction would also improve conditions for firefighter and public safety, and reduces suppression costs in the event of a wildfire. Analysis of weed removal projects will be completed in another compliance document.

Prescribed fire may also be used within the Adaptive Management FMU in order to eradicate starthistle (*Centaurea solstitialis*) and summer mustard (*Hirschfeldia incana*). The FMP EA described plans to burn 10-50 acres per year for three consecutive years in the spring (before either plant can flower), in order to eradicate these species from the FMU. While both plants respond favorably to fires, burning prior to flowering ensures that there would be limited new seed production. Burning for three consecutive years depletes the rootstock's stores of energy and/or seedbanks, leaving them less likely to re-sprout after the three-year treatment is complete. Special precautions would be taken where Adaptive Management FMU overlaps with listed species habitat when implementing fire management projects (see Mitigation Measures in Appendix D). These include not drafting water from creeks or reservoirs, timing burns during low sensitivity times, and the ban on retardant of chemicals among other things.

2.6.3 Wilderness FMU

The Wilderness FMU includes all areas outside 50 meters from paved roads, and 100 meters from buildings and structures not in the Adaptive Management Areas. This is the primary ecosystem of the Monument and includes the 16,048 acres of designated wilderness. Acceptable fire management strategies in these areas are full wildfire suppression and the use of prescribed fire to restore and maintain ecosystem structure and function. In areas designated as wilderness, a Minimum Requirement decision process evaluates the appropriateness of activities or methods and determines the best course of action, or Minimum Tool, that will be used to ensure the preservation of wilderness character. This process is included in Appendix H, Part 12. Aside from wildfire suppression efforts that are protecting life and property, all activities in designated wilderness will be those actions that are essential to preserve or restore wilderness resources and character.

The Monument staff anticipates implementing a prescribed burn program in both the Wilderness and Adaptive Management Units. The Monument's fire history indicates that, from an ecological standpoint, a "natural" fire interval has been maintained for most areas of the Monument. Therefore, our prescribed burn program will focus on the ecological needs of the ecosystem and, with the prolonged absence of fire, will develop prescribed burn prescriptions to meet the ecological needs. Since approximately 2,500 acres burn naturally every nine years, the prescribed burn program would be based on these numbers. If a fire of this size has not occurred in the Monument in a 10-year period, management could initiate a prescribed burn of this size. Areas considered suitable for prescribed fires would be areas that had not burned in over 25 years. Separate consultation regarding listed species would occur for these prescribed fires.

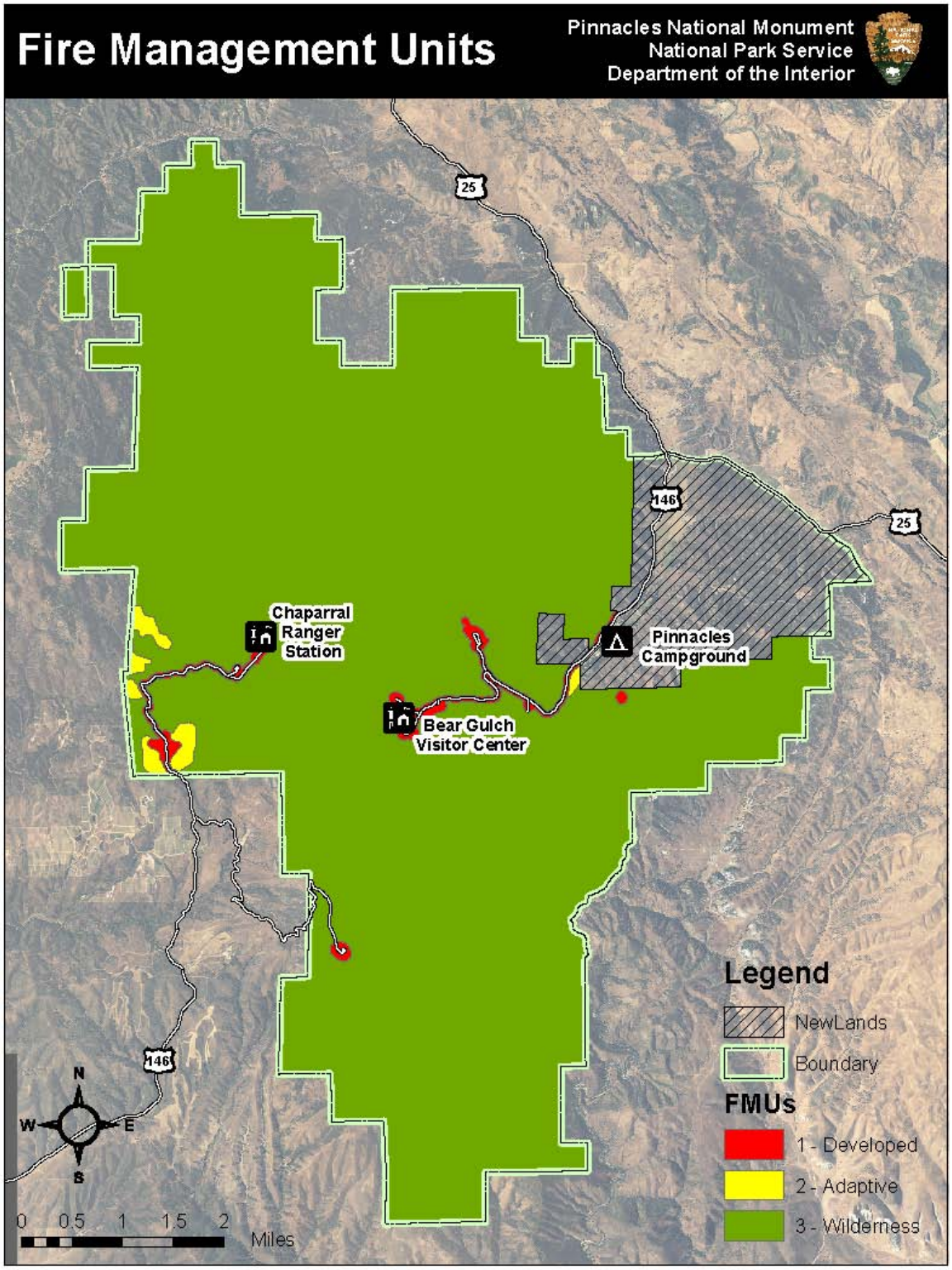



Figure 6 – Fire Management Units, Pinnacles National Monument