National Park Service
U.S. Department of the Interior

Carlsbad Caverns National Park
New Mexico

Fire Management Plan

Environmental Assessment

March 2005

Fire Management Plan
Environmental Assessment

Carlsbad Caverns

National Park • New Mexico

Carlsbad Caverns National Park needs to update its fire management plan (FMP) to incorporate new policies and advances in fire research and operations. FMP goals regard safety as the highest priority, and then address the use of fire to accomplish resource management objectives, the need to base the program on science, and requirements that the process be open and cooperative. Three alternatives are retained for analysis in this environmental assessment (EA). The No Action Alternative will continue to manage fire in accordance with the original FMP, written in 1992, renewed in 1995, and subsequently amended. Three fire management units (FMUs) define this alternative. Alternative 1 is similar to the No Action Alternative, but will consist of only two FMUs. Resource management goals will be accomplished via wildland fire use, prescribed fire, non- fire treatments, and suppression depending on the affected FMU. Under Alternative 2, the entire park will be treated as a single FMU in which no wildland fire use will be permitted.

Alternative 1 is the environmentally preferred and National Park Service preferred alternative after considering eight relevant impact topics. Under Alternative 1, fire management strategies employed at the park would result in some short- term adverse effects. Nonetheless, long- term benefits are predicted to outweigh short- term losses in fire- adapted systems, such as those at the park.

If you wish to comment on this EA, you may mail comments to the name and address below. This document will be available for public review for 30 days. Please note that names and addresses of people who comment become part of the public record. If you wish to have your name and/or address withheld, you must state this prominently at the beginning of your comment. All submissions from organizations and businesses, or from individuals identifying themselves as representatives or officials of organizations or businesses, shall be made public in their entirety.

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Executive Summary

Carlsbad Caverns National Park needs to update its *fire management plan* (FMP) to incorporate new policies and advances in fire research and operations. Because careful planning is designed to minimize adverse effects, the park has prepared this environmental assessment (EA). The new FMP must be updated annually and revised after five years, but the management directions under consideration for the new plan have been crafted to apply for more than five years.

This document is comprised of five chapters. Chapter I explains why a new FMP is needed, lists the laws and policies that must be considered, outlines the goals and objectives that the park hopes to accomplish with the new FMP, and introduces the impact topics and issues that are considered in detail in subsequent chapters. Chapter II describes alternative ways the goals and objectives could be accomplished. Chapter III describes the resources and values that could be affected by the alternatives. These descriptions are organized by impact topic. Chapter IV is an analysis of the potential environmental impacts each alternative could have, again organized by impact topic. Finally, Chapter V documents the consultation and coordination in the development of this EA.

The primary FMP goal is to protect people and property. Other important goals include protecting the park's natural and *cultural resources*, suppressing unwanted wildland fires; ensuring that fire plays its natural ecological role in the park; using fire to achieve resource management goals, such as restoring wildlife habitat and *cultural landscapes*; working closely with park neighbors to plan fire management, and coordinating fire activities with all park divisions and the public. Issues related to fire management were organized into eight impact topics: life and property, park neighbors, tourism, cultural resources, changes in landscape- scale vegetation patterns, wildlife habitat change, special-status species, and *exotic species*.

Three alternatives are analyzed in detail in this EA. The first, the *No Action* Alternative, calls for continuing to manage fire in accordance with the original FMP, written in 1995. Under this FMP, the park is divided into three *fire management units* (FMUs). FMU 1 covers most of the *wilderness* in the park, except for areas near the park boundary. Within FMU 1, wildland fire use is permitted if certain conditions are met. FMU 2 includes most of the park boundary. Wildland fire use is also permitted within this FMU, but the conditions under which it is allowed are limited. With a few exceptions, fires are not to be allowed to leave the park. There is automatic fire suppression in FMU 3, which covers the Rattlesnake Springs Unit, the developed areas of the park, an area set aside to protect *sensitive species*, and the eastern boundary of the park near Whites City. Prescribed fires and non- fire treatments can be utilized in any of the FMUs in order to achieve specific management objectives.

Under Alternative 1, a new FMP will be written that will be similar to the existing FMP, but will classify the park into just two FMUs by combining FMUs 1 and 2, as described above, into a single FMU. Wildland fire use would be permitted within this FMU if certain conditions are met, and these conditions would be less restrictive than the conditions required for either FMU in the 1995 FMP. Fire will be allowed to cross the park boundary, pending the creation of formal agreements between the park and neighboring landowners. Fire management zones have been created within the FMUs to achieve generalized management goals. Within those zones, projects are delineated for completion over the tenure of the new plan.

Under Alternative 2, the entire park will be treated as a single FMU in which no wildland fire use will be permitted. Some prescribed fire would be permitted in order to achieve very specific *fuels* reduction or research goals, but the conditions under which burning would be permitted will be very limited. Non- fire treatments are also permitted.

As this document was being prepared, drought conditions had seemingly eliminated the need for near- term prescribed burning due to the absence of the fine fuels that carry fire. Although one year does not end a drought, abundant rainfall in the spring and summer of 2004 showed how quickly conditions can change. The alternatives in this EA were developed such that a program of prescribed fire could be implemented at the park when needed. The environmental impacts of each alternative, including effects of prescribed fire, were analyzed by considering each impact topic. Consultation was undertaken with the New Mexico *State Historic Preservation Office*, and the plans of the park to protect cultural resources during fire program operations were found acceptable. A *biological assessment* (BA) prepared for the *US Fish and Wildlife Service* (USFWS) found that fire program activities may adversely affect Mexican spotted owl and Lee and Sneed pincushion cacti; however, the fire program intends to benefit these and other special- status species in the long term.

Alternative 1 is the environmentally and National Park Service (NPS) preferred alternative. Alternative 1 is likely to result in the most fire on the landscape, because it allows the most wildland fire use. As a result, fuels will be reduced to a greater extent than under the other alternatives, decreasing the likelihood that a high- severity wildland fire will cause extensive damage to park resources in the future. The return of fire to the landscape, most of which evolved with fire, should result in ecological benefits. Finally, the updated FMP that will be written under Alternative 1 will enable park staff to better protect sensitive resources.

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Chapter 1: Purpose and Need for the Plan

Carlsbad Caverns National Park sits on the eastern end of the Guadalupe Mountains in southeastern New Mexico, approximately 20 miles southwest of Carlsbad, New Mexico, and 150 miles east of El Paso, Texas (Figure I- 1, page 2). The area was established as a national monument in 1923, and was given national park status by Congress on May 14, 1930. Its purpose is to preserve and protect cave resources, the Chihuahuan Desert ecosystem, the Capitan Reef and associated natural and cultural resources. The purpose also provides a range of opportunities for public use and scientific research. The 46,766- acre park contains over 100 known caves, including world- famous Carlsbad Cavern and Lechuguilla Cave. In 1978, Congress designated 33,125 acres (approximately 71 percent) of the park as wilderness. The Wilderness Act of 1964 requires managers of legislated wilderness to "be responsible for preserving the wilderness character of the area..." The act therefore implies that allowing the continuation of natural processes, such as naturally occurring wildland fires, is an important part of 'preserving the wilderness character.'

Purpose of the Fire Management Plan

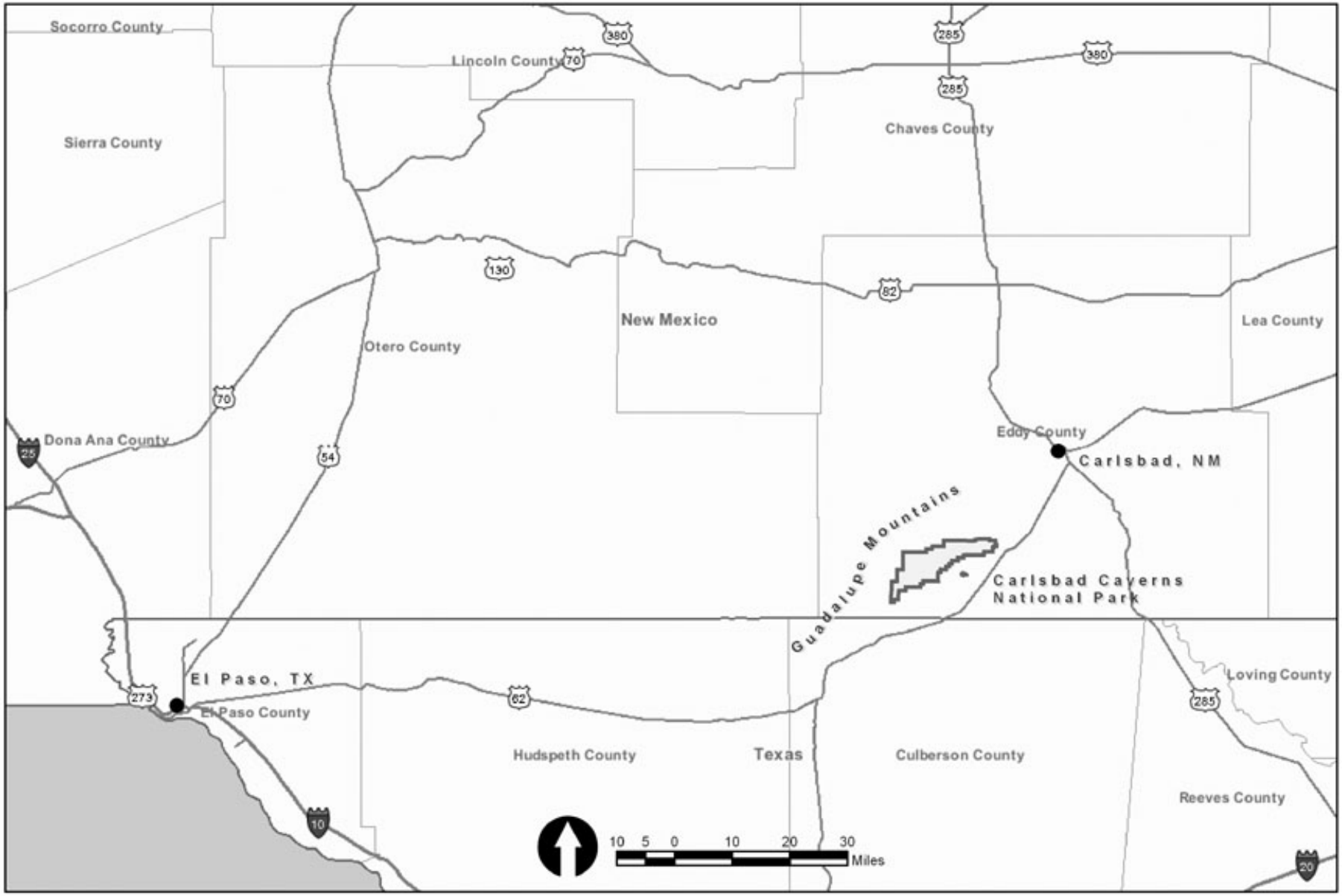
The purpose of the proposed action is to implement an improved fire management plan (FMP, refer to Appendix A for the glossary and italicized terms) at Carlsbad Caverns National Park that incorporates advances in fire knowledge, results of burning and monitoring programs at the park, new understanding of the ecology of park vegetation, and revisions in National Park Service (NPS) policy. The FMP guides all aspects of a park's fire program. The NPS's goal of updating FMPs at five- year intervals acknowledges the rapidly changing fire *context* in parks.

The revision of the current FMP requires this environmental assessment (EA) to address and analyze alternatives for carrying out the fire management program. This EA was prepared to comply with the requirements of the *National Environmental Policy Act* (NEPA). In Chapter II, the EA develops three alternatives in detail. The first of the three is the No Action Alternative that maintains the three fire management units (FMU) described by the current FMP. The second alternative designates a prescribed burning and appropriate management response unit around park developments and sensitive areas and along the east side of the park. The rest of the park makes up the second unit, where the Full Toolbox of fire management tools is available. The third alternative calls for fire management to be the same throughout the park, with *prescribed fire* for research purposes only and all wildland fire suppressed.

If Alternative 1 is adopted, the new FMP will direct the fire management program through specific fire management activities that accomplish land and resource management objectives and reduce the risk of unwanted fire in, and adjacent to, the park. Depending on the area needing attention, the park will use different methods to manage fire, restore ecosystem health, and reduce buildup of burnable vegetation. In addition to a broad range of *suppression* tactics known as appropriate management response, these methods include prescribed fire, mechanical fuel reduction, and *wildland fire use*. Wildland fire use describes those lightning fires that are permitted to burn if they meet objectives defined by park managers and are in areas predetermined to be suitable for natural fire. Strategies for implementation would be based on knowledge gained from fire and fuels research, monitoring, and experience at the park over the last several decades.

Throughout this document, common names for plants and animals are used. Refer to Appendix B for a list of common and the accompanying scientific names.

Figure I- 1. Location of Carlsbad Caverns National Park.



Need for the Fire Management Plan

Since 1968, NPS policy has allowed natural (lightning) ignitions to be managed to restore or maintain ecological conditions and processes. This practice is known as wildland fire use. The fire management program has pursued this policy for over three decades at Carlsbad Caverns National Park. There is an on- going need to refine and improve the fire program because:

- Fire has a natural role in maintaining ecosystems at the park, some of which have been altered by past grazing and suppression activities. Fine- tuning of the fire management program is needed to reflect advances in fire knowledge and lessons learned from burning and monitoring programs in the park.
- Human communities, cultural resources (i.e., historic landscapes, structures, artifacts, pictographs), and park developments need protection from unwanted wildland fires.
- New planning for fire treatments and pretreatments is needed that will reduce the risk of potential property loss.
- Management of wildland fires, prescribed burning, and fuel reduction treatments requires up- to- date contingency planning and preparation.
- Fire management activities require renewed and enhanced collaboration with federal, state, county, tribal, and local agencies. An updated FMP also provides a basis for communication, coordination, and project planning with partner agencies.
- Carlsbad Caverns National Park must comply with the 2001 Federal Wildland Fire Management Policy, which was initiated with the 1994 fire season with its 34 fatalities and growing recognition of fire problems caused by fuels accumulation. In 2001, changes were made to address issues of ecosystem sustainability, science, education, communication, program evaluation and planning

Fire history, fire ecology, prescribed burn program results, effects of drought, and fire regulations and policies are summarized below. This background is needed to understand why the park has a fire program and why managers would now like to accommodate additional fire management options.

Fire History

The frequency of fires set by Native Americans or lightning prior to the late 1800s is not known for the vegetation communities in the Chihuahuan Desert. Ahlstrand (1981) reported a significant decrease in fire frequency after Native Americans were excluded from former mescal gathering and roasting areas by Europeans in the mid 1800s. Intense grazing eliminated fuels that could support fires in many areas in the Southwest (Swetnam et al. 1999). For the period between 1496 and 1922, fire frequency of about every 5 to 10 years, with widespread fires every 17 years, was estimated from tree- ring fire- scar data in higher- elevation forests and woodlands of Guadalupe Mountains National Park (just southwest of Carlsbad Caverns National Park in the same mountain range) (Ahlstrand 1981).

Over the past 150 years, heavy livestock grazing, climate change, and fire suppression have contributed to the increase of shrubs and decrease of grasses. Although fire is a natural disturbance in lower elevation Chihuahuan Desert ecosystems, fire frequency in grasslands and shrublands is difficult to determine due to lack of direct evidence. The literature suggests about 5 to 15 years as a fire- return interval that maintains grassiness in the face of invading shrubs in the Chihuahuan Desert (Kittams 1972; Ahlstrand 1982). Given the southwest- to- northeast wind- driven pattern of fires in the Guadalupes, it is likely that some of the historically frequent fires starting upwind in the Guadalupe high country reached Carlsbad Caverns National Park. Long- term fire effects studies in the region

have yet to be carried out (Gebow and Halvorson 2002). The park has 10 years of data from its fire effects monitoring program that are highly variable, but the fire ecologist plans to reanalyze the data set in the future.

In the 1980s, park managers worked to exclude trespass livestock migrating into the park from adjacent private and federal lands by fencing the park perimeter. The sudden cessation of heavy grazing, coupled with abnormally wet years, produced a bumper crop of grass and other herbaceous vegetation intermingled with the shrub and succulent vegetation. The resulting fuel conditions readily sustain ignitions not rained out or suppressed, as shown by several recent fires in and around the park, such as the 33,135- acre Big Fire of 1990 (11,040 acres on the park, 22,095 acres on neighboring *Lincoln National Forest* and *Bureau of Land Management* (BLM) lands).

Figure I- 2 (page 6) plots the known fires in the park database. Figure I- 3 (page 7) compiles ignition types over time for 264 fires recorded from 1941 to 2000. Lightning fires accounted for 65.2 percent of the total number of ignitions for the 60- year period. Until the mid- 1960s, though, lightning fires ran a close second to human actions, particularly smoking, as the main cause of fires in the park. Prescribed burning first shows up in the park's fire record in 1979. Table I- 1 (page 7) shows acres burned by cause, with acres burned by lightning and prescribed burning increasing over time.

Fire Ecology

Over the past 20 years, fires at Carlsbad Caverns National Park initially resulted in an increase in grasses and a reduction in shrubs, cacti and agaves (Kittams 1972, Ahlstrand 1982). However, most woody species are not killed by fire and respond to burning by producing vegetative sprouts at the protected plant base. Perennial herbs often persist after fires and many annual seeds germinate after burning. Annual and perennial grass responses after fire depend on the season burned. Studies show that with normal precipitation, blue grama is not harmed by prescribed burning, but may decrease for 2 to 3 years under drought conditions (Wright 1978). Another study examining the effects of fire on the less common black grama has shown that fire can be detrimental (Cornelius 1988). Non- native grass species, such as Lehmann lovegrass, recover from fire more quickly and may displace native plants and wildlife. Summer burns can kill perennial grasses, especially if followed by a post- burn drought (Debra Peters, Jornada Long- Term Ecological Research Site, personal communication). Refer to Appendix B for the list of common and scientific names.

Damage to plants is a function of growth form (annual or perennial, herbaceous or woody), phenology (annual growth and reproduction cycle), height, fuel, fire *intensity*, soil type, dryness, and position of buds and seeds (Daubenmire 1960). Redberry juniper (also known as Pinchot juniper), a common woody species at Carlsbad Caverns National Park, is reported to require high fuel levels to ignite, but once ignited burns vigorously, increasing the intensity of the fire (Kittams 1972). Ahlstrand (1982) found most grass species in the Carlsbad Caverns National Park area of the Guadalupe Mountains had returned to pre- burn levels after three growing seasons and continued to increase over the next few years. He suggested that burning every 10- 15 years would be required to keep shrubs from dominating the landscape at the expense of grasses. After frequent fires, community composition will shift toward species that are less susceptible to fire (Daubenmire 1960). Repeated burning favors forbs over grasses and annuals may increase at the expense of perennials.

Fire in desert scrub and grassland is thought to be an irregular, but not necessarily an uncommon event, dependent on years of higher precipitation to produce fine fuels necessary to carry fire. Fire every 10- 15 years is suggested for a Chihuahuan Desert grassland management target (Ahlstrand 1982; Kittams 1972). Although soil type and precipitation patterns more than fire likely dictate gross vegetation distribution patterns in the Chihuahuan Desert (Dick- Peddie 1993; Grover and Musick

1990), irregular, patchy presettlement wildland fire in the Guadalupe Mountains has probably contributed to smaller- scale patterns of distribution and diversity. Throughout most of the 20th century, most lightning ignitions were quickly detected and suppressed, or were rained out before a suppression response could be initiated.

When considering the application of fire, however, it is important to evaluate recent changes in land use practices, exotic plants and animals, and other factors that could influence the response to fire (Gill 2001). Restoration of the desired ecosystem prior to the reintroduction of fire may be necessary to achieve the desired outcome (Swetnam et al. 1999).

Burn Program

In the late 1970s, managers at the park grew interested in reestablishing fire as one of the natural processes maintaining park ecosystems. They also recognized that carefully placed fires could reduce fuels built up around valuable cultural and *natural resources* and help protect them from destructive wildland fires. Management- ignited fires, now termed prescribed fires, are defined as fires intentionally ignited to achieve certain resource management objectives in specific areas under a *prescription* identified in an approved fire plan. Since 1979, the park has carried out 40 prescribed burns covering roughly 7,600 acres.

Fire managers have also embraced the idea of letting naturally ignited fires burn if they meet park objectives. Wildland fire use requires a natural ignition (usually lightning), burning under a specific prescription, in a preplanned location, and with adequate fire management personnel and equipment available to achieve specific resource management objectives. Wildland fire use is carefully monitored and documented. Since 1993, 15 lightning ignitions in the park have met the criteria for wildland fire use for resource benefit, burning approximately 4.5 acres in total. One purpose of fuels treatment projects is to prepare the park for wildland fire use and have those natural fires ultimately preclude the need for major prescribed burning.

Suppression is necessary in some areas of the park under certain conditions. Minimum impact suppression techniques are applied to those areas of the park designated as wilderness (roughly 71 percent) to insure the wilderness character of the park is preserved. In addition, suppression activities at the park will utilize an appropriate management response using either suppression or confinement (or a combination), based upon which is best able to provide for firefighter safety and cost-effectiveness, while protecting public safety and other values of concern. Appropriate management response refers to all fire management options available to the fire manager, as well as the level of action that would be taken in terms of suppression resources.

Effects of Drought

During preparation of this EA, park fire ecologist Richard Gatewood completed an analysis of the relationship between wildland fire and rainfall. Annual rainfall averaged over a 5- year period is highly correlated with the number of fires that occur in the following 5- year period. Over recent decades, average rainfall peaked in the 1981- 1986 period and has continued to decline to the present. Average rainfall for 2001- 2003 is the lowest for the period of record for fires in the park (since 1941) and the current 5- year annual average of 10.3 inches is close to the 10.1- inch average for the extreme drought that occurred between 1951 and 1955.

Figure I- 2. Recorded Fires at Carlsbad Caverns National Park 1941- 2004. Polygons show entire extent of fires; points show approximate locations of fire starts.

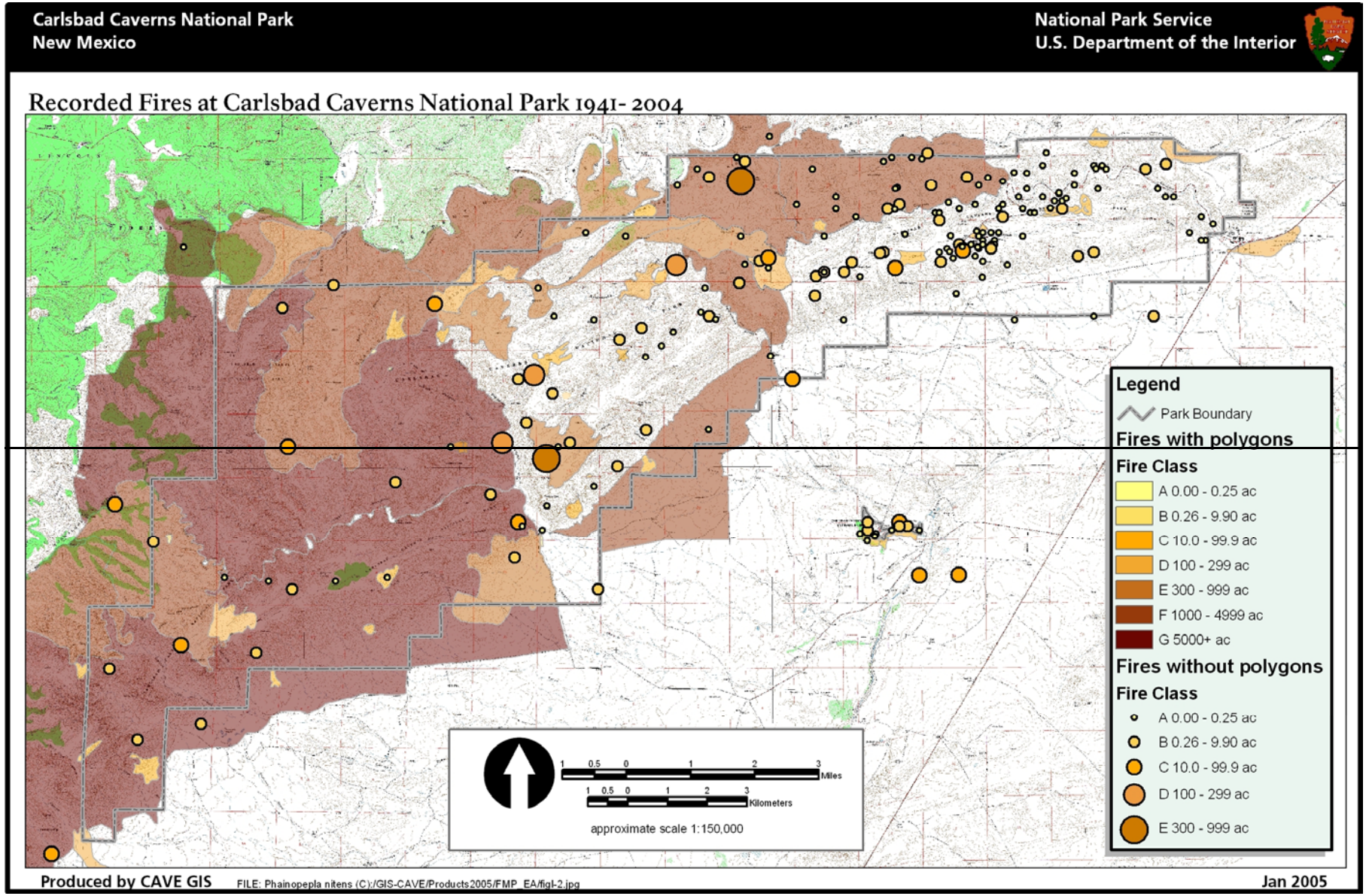


Figure I- 3. Number of Fires by Ignition Source for Carlsbad Caverns National Park 1941-2000. (Gebow and Halvorson 2002)

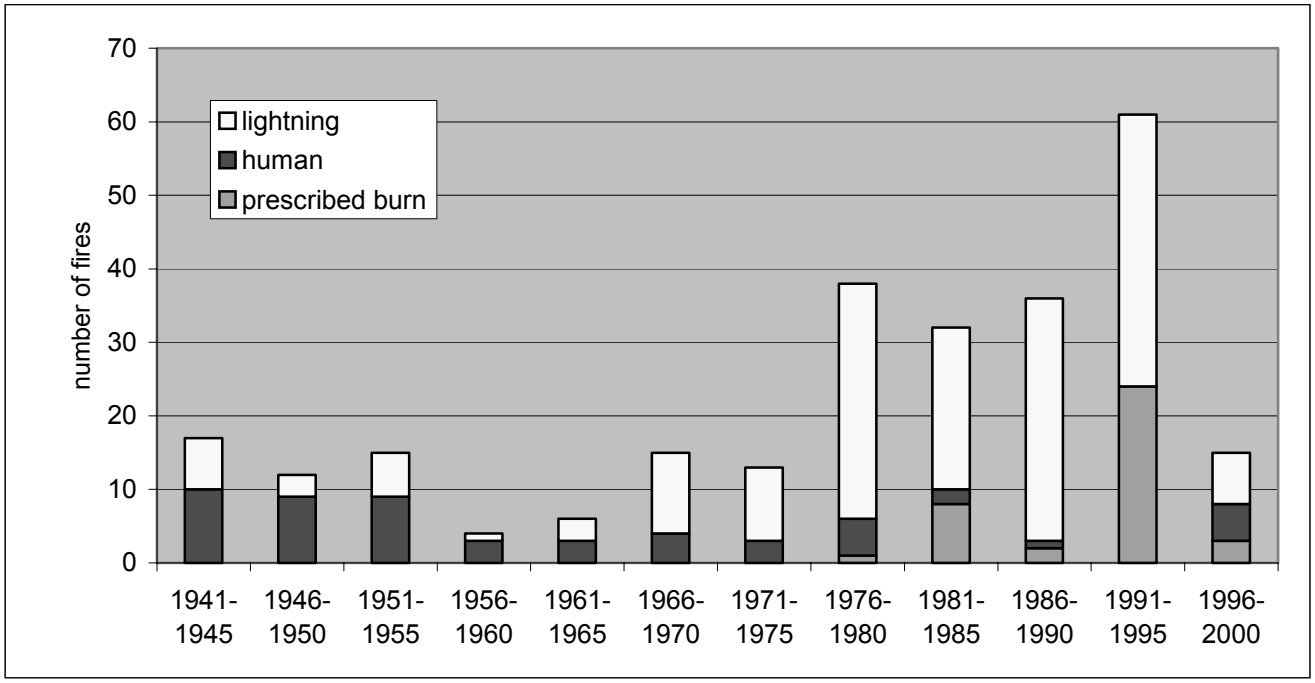


Table I- 1. Acres burned at Carlsbad Caverns National Park by ignition type per five- year interval, 1941- 2000. (Gebow and Halvorson 2002)

Time period	Prescribed burn	Human	Lightning
1941- 1945	0	45.8	223.8
1946- 1950	0	23.8	4.2
1951- 1955	0	0.9	190.5
1956- 1960	0	58.4	14.9
1961- 1965	0	35.3	0.3
1966- 1970	0	108.6	76.7
1971- 1975	0	0.3	16,495.5
1976- 1980	0.1	59.4	941.2
1981- 1985	98.7	3	3249.3
1986- 1990	4.02	33,139	6,895.5
1991- 1995	4,632.4	0	598.6
1996- 2000	1,970.2	0.3	1.9

Because of drought conditions, minimal fine fuel production substantially reduced the potential for fire spread between 1999 and 2003. Given the lack of fine fuel, park managers were on the verge of concluding that over the next 5 years and possibly longer, suppression activity would be minimal, wildland fire use events small, and prescribed fires unable achieve resource management objectives; however, 2004 brought record precipitation. If rainfall significantly exceeds the long- term average

(14.9 in) for several years, the need for near- term prescribed burns increases dramatically at Carlsbad Caverns National Park. The alternatives described in Chapter II assume there will be sufficient fuels buildup to warrant scheduling and conducting prescribed burns.

Regulations and Policies

The NPS recognizes the occurrence and the absence of fire as integral factors influencing parks. Summarized below are some of the fire management policies set forth in Section 4.5 of the NPS Management Policies (NPS 2000):

- Fire management programs will meet resource management objectives while ensuring protection of life and property.
- Parks with vegetation capable of burning will prepare FMPs and address funding and staffing required by fire programs.
- Fire plan development will include the NEPA compliance process and necessary collaborations with outside parties.
- Fires in vegetation are to be classified as wildland or prescribed fires.
- Wildland fires are managed according to considerations of resource values, safety and cost.
- Prescribed fires are ignited to achieve resource management goals and closely monitored to determine whether they successfully meet objectives.
- Parks lacking approved plans must suppress all wildland fires using methods that are the most cost effective and cause the least impact.
- Suppression in wilderness will be consistent with the *minimum requirement* concept.

Many other plans and policies direct the formulation of the FMP and the environmental analysis that supports it:

- Archaeological Resources Protection Act (1979) – provides for the protection of archeological resources on public lands
- American Indian Religious Freedom Act (1978) – protects access to sites, use and possession of sacred objects and freedom to worship through ceremonials and traditional sites
- Carlsbad Caverns National Park General Management Plan (GMP) (CCNP 1996) – determines overall management direction for the park for 12 to 15 years
- Carlsbad Caverns National Park Resource Management Plan (RMP) (CCNP 1995b) – sets natural and cultural resources management and research priorities
- Clean Air Act (as amended 1990) – includes national ambient air quality criteria; states that federal land managers have an affirmative responsibility to protect air quality related values from adverse impacts
- A Collaborative Approach for Reducing Wildland Fire Risks to Communities and the Environment: 10- Year Comprehensive Strategy Implementation Plan (National Interagency Fire Center 2002) – a strategy for reducing wildland fire risks and improving collaboration with affected agencies and parties
- Director's Order 12: Conservation Planning, Environmental Impact Analysis, and Decision Making (NPS 2001) – interprets the National Environmental Policy Act for the NPS
- Director's Order 18: Wildland Fire Management: (NPS 1998) – expresses NPS fire policy

- Endangered Species Act (1973) – provides for listing and protection of endangered and threatened species and their critical habitats; requires consultation under Section 7 if any listed species may be adversely affected
- Executive Order 11988: Floodplain Management (1977) – provides for the protection of floodplains
- Executive Order 11990: Wetlands Protection (1977) – provides for the protection of wetlands
- Federal Water Pollution Control Act (1972; amended as "Clean Water Act" in 1977) – limits discharges into US waters to maintain water quality
- Federal Wildland Fire Management Policy (1995) Review and Update (National Interagency Fire Center 2001) – provides a common approach to wildland fire management for US Department of Interior (USDOI) agencies and the *US Department of Agriculture Forest Service* (USDA/USFS)
- Managing Impacts of Wildfires on Communities and the Environment, and Protecting People and Sustaining Resources in Fire Adapted Ecosystems—A Cohesive Strategy (USDOI/USDA 2002) – provides an approach for protecting communities in rural areas from wildland fires
- National Fire Plan (2001) – manages the impact of wildland fires on communities and the environment
- National Parks and Recreation Act (1978) – requires park management to provide measures for the preservation of the area's resources, consider how development affects public enjoyment, identify visitor carrying capacity
- NPS Organic Act (1916) – defines NPS management responsibilities as conserving scenery, natural and historic objects, and wildlife to provide for the enjoyment of future generations
- National Environmental Policy Act – NEPA (1969) – requires federal agencies to consider environmental values and integrate them into their proposed actions
- *National Historic Preservation Act* – NHPA (1966) – guides preservation of historic properties
- Native American Graves Protection and Repatriation Act (NAGPRA 1990) – provides a process for museums and federal agencies to return certain Native American cultural items to their descendants and affiliated tribes
- Reference Manual 77 (NPS 1999 and in progress) – offers comprehensive guidance to NPS employees responsible for managing, preserving, and protecting the natural resources found in National Park System units
- Wilderness Act (1964) – outlines criteria for consideration of areas as part of the National Wilderness Preservation System and the restrictions that apply to use and management of these areas
- Wildland Fire Management Reference Manual 18 (2001) – contains NPS wildland fire management requirements and procedures

Relationship of the Proposed Action to Previous Planning Efforts

The FMP (CCNP 1995a), written in 1992, renewed in 1995, and amended in 2002 and 2004, was in effect at the time of the preparation of this EA and is described in the No Action Alternative.

1995 Resource Management Plan

The FMP is an integral element of the Carlsbad Caverns National Park 1995 *Resource Management Plan* (RMP) (CCNP 1995b). It describes the natural and cultural resource management programs needed to accomplish the legislated mandates of the NPS and Carlsbad Caverns National Park and apply the policies, program emphases, and provisions of related planning documents. The RMP identifies the need for fire management programs and includes project statements specific to fire management, the restoration and maintenance of natural ecosystems and ecosystem processes, and the maintenance and protection of cultural resources. The RMP states that fire is a vital process in park wilderness. It also recognizes the need for fuel reduction in and adjacent to developed areas and sensitive resources.

1996 General Management Plan

General management plans are required for national parks by the National Park and Recreation Act of 1978. Carlsbad Caverns National Park's *General Management Plan* (GMP) (CCNP 1996) is the fundamental document for managing the park. Discussion and direction related to fire are summarized as follows:

- Fire is believed to have a profound influence on the Chihuahuan Desert grassland ecosystem.
- The FMP will guide regular use of prescribed fire across the park.
- Results of further research into the role of fire in the Chihuahuan Desert will be incorporated into the fire management program.
- Studying effects of fire on archeological sites is relevant to the application of prescribed fire and wildland fire use.
- Fire management issues often extend beyond park boundaries.

The 2005 *Fire Management Plan* would further the fire management- related provisions of the GMP and would outline the programs needed for protecting visitors, employees, and property from risks associated with wildland fire.

2005- 2008 Strategic Plan

The park's *Strategic Plan for 2005- 2008* (CCNP 2005) includes Land Health Goals for uplands, wetlands, and riparian areas. Over the next several years, the park plans to determine desired conditions for these land types within its boundaries. The desired condition of a resource type is an objective description of what the resource should be like, with the physical and biological conditions known and described. Given the history of fire in this area, a natural fire regime would certainly be a component of land health for some park lands. In ensuing years, the park will assess the existing conditions (land health), determine how different they are from the desired conditions, and begin working toward achieving desired conditions throughout the park.

Parties to the Planning Process

Numerous groups of individuals were involved and consulted in the preparation of this EA:

Interdisciplinary Team (IDT): The IDT is composed primarily of park staff who are ultimately responsible for writing and carrying out the plan that results from this EA. The team included expertise in natural and cultural resources, fire operations, park administration, and visitor services. The team also included individuals from the University of Arizona who served as facilitators for the NEPA process and editors for this EA. Chapter V lists the IDT members.

***Government Agencies*:** The IDT considered the input of the USFS, BLM, and the State of New Mexico who administer lands adjacent to the park. Consultation with the US Fish and Wildlife Service (USFWS) regarding three federally listed species included preparation of a BA by the park (submitted November 11, 2003) and issuance of a *biological opinion* (BO) by USFWS is expected soon. Park staff informed the New Mexico Department of Game and Fish (NMDGF) by letter on February 23, 2004, of its intention to produce a new FMP. They were invited to review the parks' assessment of effects of the proposed fire management alternatives on sensitive plant and animal species, in an accompanying BA and EA.

Cultural Resources Consultations: Plan development included consultation with the New Mexico State Historic Preservation Office (SHPO) on cultural resources. The FMP *Cultural Resources Component* (CRC) was submitted to the SHPO in lieu of the entire EA. The summary matrix from the CRC can be found in Appendix C of this document.

Tribal Governments: Currently, the park consults with the Mescalero Apache Tribe, Ysleta Del Sur Pueblo (Texas), Hopi Tribe, Pueblo of Isleta (New Mexico), Jicarilla Apache Nation, Pueblo of Zia, Pawnee Nation, Commanche Nation, Kiowa Indian Tribe, San Carlos Apache Tribe, White Mountain Apache Tribe, Zuni Tribe, Apache Tribe of Oklahoma, and the Fort Sill Apache Tribe. These groups received the FMP *scoping* newsletter in November 2002. The park provided details of the proposed action and fire planning process to the Mescalero Apache tribal president, the Ysleta del Sur Pueblo, the Hopi Tribe Office of the Chairman, and other groups in 2003. Comments were not received from any affiliated tribes.

Peer Reviewers: Ellis Richard, recently retired superintendent of Guadalupe Mountains National Park, and the USFWS New Mexico Ecological Services Office reviewed the EA in internal draft form.

Interested Public: The written comments of attendees of public scoping meetings, neighbors, and other interested members of the public have been considered during the development of the plan. Members of the public; federal, state, and local agencies; and the NPS identified important issues during two scoping periods. An internal scoping meeting took place in June 2002. On November 15, 2002, the public scoping period was announced with the publication in the Federal Register of a Notice of Intent (NOI) to prepare an environmental impact statement (EIS) for an updated Carlsbad Caverns National Park FMP. The park jointly held four public meetings with neighboring Guadalupe Mountains National Park in November 2002. The parks are five miles apart, display similarities in vegetation and geology, share a fire management officer and other fire staff, and are operating on similar schedules for updating their FMPs. A newsletter that announced the meetings and described the preliminary fire planning issues and alternatives was sent to both parks' mailing lists two weeks before the meetings. Meeting attendance (signed in) was as follows:

- November 18, El Paso, Texas: 2
- November 19, Dell City, Texas: 5
- November 20, Queen, New Mexico: 17
- November 21, Carlsbad, New Mexico: 18

At these meetings, ample staff from the park were on hand to discuss the alternatives and issues related to fire management in the park. Written comments expressed support for (1) returning fire to the landscape and (2) working cooperatively with neighbors to manage fire.

As the park progressed on compliance for NEPA, federally listed species and cultural resources, analyses showed an absence of significant adverse effects. Thus a NOI was published in the Federal

Register on December 17, 2004 to produce an EA rather than an EIS. The level of analysis of effects is the same for both documents; the approval process, however, is more streamlined for an EA because its findings reveal no significant impacts to the environment from proposed management actions.

Fire Management Plan Goals and Objectives

FMP goals and objectives were developed by the interdisciplinary team. The FMP will describe a detailed program of actions that fulfills these goals and objectives. The goals and objectives of the plan have their foundations in the park's GMP (CCNP 1996) and RMP (CCNP 1995b), NPS policies, federal legislation, and federal wildland fire policy.

Goal 1: Protect people and property as the highest priority of every fire management activity.

a) Provide for the safety of visitors, firefighters, and staff during wildland and prescribed fire operations.

b) Protect park developments and private property from the unacceptable effects of fire.

c) Reduce fuels with prescribed fire and *thinning* in places where wildland fire is a threat to people and property.

d) Implement programs to prevent unplanned human- caused ignitions and reduce human-caused wildland fires.

e) Strive to meet health and safety standards that relate to fire, particularly for air quality and on-the- job safety.

Goal 2: Protect the park's natural and cultural resources from undesirable effects of fire and suppression.

a) Reduce fuels with prescribed fire and thinning in places where fire would damage or degrade any identified cultural or historic resource, or adversely affect sensitive vegetation or wildlife habitat.

b) Employ minimum impact management tactics, particularly in wilderness or other sensitive areas.

Goal 3: Suppress unwanted fire.

a) Ensure the park is adequately prepared to suppress unwanted wildland fire.

b) Automatically suppress human- caused fire.

c) Prevent unwanted fire from spreading onto neighboring government and private lands.

Goal 4: Maintain or restore fire as a natural dynamic ecosystem process.

a) Determine fire role and effects with regard to natural resources. In particular, attempt to determine (1) range of natural variation related to fire (in time, space, and intensity), (2) role of fire, and (3) fire effects on the ecosystem of the Chihuahuan Desert and Guadalupe Mountains.

b) Promote and develop research and monitoring in the park relative to data needs.

c) Search for sources of information relative to data needs, such as the results of scientific research, historic records, and the experience of individuals familiar with fire in the Guadalupe Mountains.

d) Specify and aim for desired conditions, monitor effects, and integrate results into fire program.

Goal 5: Use of wildland fire and prescribed fire for resource management purposes.

a) Return fire to fire- dependent ecosystems.
b) Allow natural- ignition fire to burn in predetermined areas and under prescribed conditions.
c) Reduce fuels in places where fire would adversely affect resources and to prevent fire from escaping park boundaries.
d) Look for opportunities to use fire to restore and maintain cultural landscapes.
e) Use prescribed and wildland fire for wildlife habitat restoration.

Goal 6: Facilitate joint planning and implementation of fire operations with neighboring agencies and private landowners.

a) Collaborate with neighbors to protect private lands adjacent to the park.
b) Enter cooperative agreements with neighboring agencies and landowners on fire- related activities.
c) Conduct mutual fire research programs wherever possible.
d) Work in partnership to deliver consistent messages about fire prevention and management.

Goal 7: Coordinate fire activities with all park divisions and the public.

a) Maintain open lines of communication with the public and all park divisions.
b) Incorporate appropriate fire management tasks into all park divisions.
c) Initiate a public information and interpretation program that will encourage visitor and community support of the park's fire management program.

Fire Planning Impact Topics

NEPA requires consideration of a specific list of mandatory topics. Table I- 2 (page 15) lists those topics and the IDT's assessment of how they apply to Carlsbad Caverns National Park. Specialists on the IDT identified issues and concerns affecting the proposed actions with the help of the NPS Intermountain Region Environmental Screening Form. Those issues are listed in Appendix D. After assembling that extensive list, the IDT sorted the issues into the eight specific impact topics below. The IDT developed specific issue statements to ensure appropriate comparison of fire management alternatives.

The preparers decided not to cover wilderness as a separate impact topic, since it is woven throughout the existing topics and is protected equally within all the alternatives. Factors sustaining this decision include: the park's policy of allowing natural fire in wilderness, its consideration of minimum tools in such areas under all alternatives; *mitigation* measures under natural and cultural impact topics; and the fact that there are few visitors in the wilderness. Designated wilderness covers 71 percent of the park, and it shapes management of all natural resource impact topics and all fire alternatives. By law, minimum impact suppression techniques form the backbone of wilderness fire management under all alternatives. The park's RMP (CCNP 1995b) states that the park's wilderness "will be managed as a natural zone wherein fire will be restored to its natural role as a primary agent in the maintenance of natural vegetation mosaics, and… will be allowed to continue unimpeded."

- **Impact Topic 1: Life and Property**
  Fire is an effective tool for reducing hazard fuels, but can pose a threat to firefighters, park staff, developed areas, and the public.

- **Impact Topic 2: Park Neighbors**
  Park neighbors are concerned about fire crossing park boundaries.
- **Impact Topic 3: Tourism**
  Local businesses may experience temporary declines in business if park visitation declines due to fire.
- **Impact Topic 4: Cultural Resources**
  Fire may help reduce surrounding hazard fuels and maintain the historic scene, but historic structures, landscapes, and artifacts may incur fire damage.
- **Impact Topic 5: Changes in Landscape- Scale Vegetation Patterns**
  Fire may change the landscape, altering the present "look" of the park.
- **Impact Topic 6: Wildlife Habitat Change**
  Fire may change wildlife habitat, potentially causing some species to decrease in abundance and others to become more abundant.
- **Impact Topic 7: Special- Status Species**
  Fire management activities may affect threatened, endangered, or sensitive species.
- **Impact Topic 8: Exotic Species**
  Prescribed and wildland fire, mechanical fuel reduction, and suppression activities can all promote certain exotic species that invade disturbed areas.

Table I- 2. NEPA Mandatory Topics

Category	How Addressed
Possible conflicts between the proposed action and land use plans, policies, or controls for the area concerned	Relevant plans and policies are listed in Chapter I (Purpose and Need). No conflicts are present.
Energy requirements and conservation	Vehicle use to support fire management activities consumes fuel. A return to more natural fire processes saves fuel. This topic was dismissed from further consideration because energy consumption is not a factor that affects selection of fire management strategies.
Consumption of natural or depletable resources, and conservation potential	Fire and fire management activities consume renewable natural resources, such as vegetation and water and non- renewable vehicle fuel. Resource consumption can be mitigated. NPS policy dictates minimum requirement techniques for dealing with fire in wilderness. The rest of this impact topic was dismissed from further consideration because consumption of other resources is not a factor that affects selection of fire management strategies.
Urban quality	Carlsbad Caverns National Park is located in a rural area. Therefore, this impact topic was dismissed from further consideration.
Socially or economically disadvantaged populations	Fire management actions must consider impacts to humans (Goal 1). There are no impacts predicted to fall predominantly upon disadvantaged populations. The park is located in a largely unpopulated rural area; therefore, this topic was dismissed from further consideration.

Category	How Addressed
Wetlands and floodplains	Several significant drainages exist within the park, including Walnut Canyon, Rattlesnake Canyon and Slaughter Canyon. The NPS is required to address effects of fire management actions on these floodplains (E.O. 11988). Rattlesnake Springs is a riparian wetland. Fire can alter hydrologic processes that may affect erosion and flooding potential; this possibility is addressed under Impact Topics 5 (Changes in Landscape- Scale Vegetation Patterns) and 6 (Wildlife Habitat Change) in this EA.
Prime and unique agricultural lands	This topic was dismissed because these lands are not found within the park, per the USDA Natural Resources Conservation Service.
Federally listed species	The park has consulted with the USFWS on a proposed FMP, prepared a BA that analyzes effects on three listed species in the park, and expects to receive a BO soon. Impact topic 7 (Special- Status Species) discusses listed species. Chapter III (Affected Environment) provides background and Chapter IV (Environmental Consequences) summarizes impacts.
Important cultural resources	These features fall under the cultural resources Impact Topic (4) in this EA. The park produced a Cultural Resources Component (CRC), Appendix C, that analyzes cultural issues and received approval of it from the New Mexico SHPO on March 15, 2004. Chapter III (Affected Environment) provides background and Chapter IV (Environmental Consequences) summarizes the CRC's analysis. Park staff also consulted with appropriate tribes.
Ecologically critical areas	Such areas are addressed under Impact Topics 5 (Changes in Landscape-Scale Vegetation Patterns) and 6 (Wildlife Habitat Change) in this EA.
Public health and safety	These highest priority concerns are addressed under the life and property impact topic (1) in this EA.
Sacred sites	This area is addressed under the cultural resources impact topic (4) in this EA and in the CRC (Appendix C) delivered to the New Mexico SHPO.
Indian trust resources	No need to address. There are no Indian trust resources in the park.

Dismissed Topic

Virtually all impact areas outlined in Appendix D are discussed under one or more of the eight topics listed above. In addition, this topic is covered but not explicitly included in the impact topics:

- ***Geological Resources***: There have been no fire- related geological resources problems in the history of the park. Erosion or wasting at a level causing concern is not likely since the rocky broken landscape prevents fires from devegetating large contiguous areas.

Chapter II: Alternatives

Fire history and background on the fire program were discussed in Chapter I. This chapter describes the alternatives selected for analysis for fire management planning at Carlsbad Caverns National Park. Each alternative proposes a different mixture of fire management techniques in the park, as well as manual fuels reduction to reduce fuels in developed areas. Chapter III, Affected Environment describes the environmental context for the alternatives introduced in this chapter, and then a detailed description of the impacts of each alternative follows in Chapter IV, Environmental Consequences.

Range of Alternatives

This section introduces the five fire management program alternatives developed by the Carlsbad Caverns IDT at its internal scoping session of June 5 and 6, 2002. Two have been dismissed as unreasonable according to current NPS policy and/or due to conflict with Carlsbad Caverns fire management goals and objectives. The reason for dismissal is discussed below, following the introduction to the alternatives in question.

The action alternatives considered in this EA were based on park staff expertise; comments and concerns expressed by the public; existing park plans; NPS policies; the National Fire Plan and 2001 Federal Wildland Fire Management Policy; input from federal, state, and local agencies; and input from cooperators from the University of Arizona, School of Natural Resources.

In the current fire planning effort, the difference between No Action and Alternative 1 (preferred alternative) is in the delineation of fire management units (FMUs). Boundaries for each FMU are clear, and a specific set of fire management strategies is defined in each. FMUs are areas of the park where particular fire management strategies are permitted, taking into account sensitive resources, safety concerns, and the potential for fires to escape the park.

Three alternatives have been retained as reasonable. Reasonable alternatives are those that (1) are best able to help the park meet its goals and objectives, (2) are in compliance with federal policy and law, and (3) minimize effects on the environment to the best of the park's ability. These alternatives are No Action, which continues the current management direction with three fire FMUs; Alternative 1 with only two FMUs, and Alternative 2, where the entire park will be treated as a single FMU in which no wildland fire use will be permitted. Alternative 1, the environmentally preferred and park-recommended, or preferred, alternative, best avoids adverse effects and satisfies the desired future condition of long- term benefits to biological, cultural and physical resources.

Fire Program Tools

The fire management program at Carlsbad Caverns National Park can implement several strategies, or tools, to manage fire within its boundaries. Managing fire can include suppression, prescribed fire, wildland fire use, or manual fuels reduction treatments. Suppression is generally an immediate emergency response to mitigate the potential damage fire may cause. Prescribed fire, wildland fire use, and fuels reduction treatments are more proactive fire management tools that are employed to the extent possible to maximize fire's benefit to the environment and to minimize undesirable effects.

Suppression: Suppression pertains to all alternatives and is an immediate response to a fire start to address threats the fire has to human health and safety, cultural and/or natural resources, park infrastructure, or neighboring property. When suppression action is taken, the first concern is to provide for firefighter safety. No suppression action will be taken that will place firefighters at unnecessary risk. When firefighter safety can be provided for, suppression actions will also seek to

minimize impacts to the resources, generally accomplished through *minimum impact suppression techniques* described more fully below in the section *Elements Common to All Alternatives*.

Prescribed Fire: Prescribed fire also pertains to all alternatives and is generally employed for two reasons. One is to reduce fuels under conditions that do not result in undesirable high- intensity or high- severity effects. It may also be employed to emulate a natural fire regime in order to maintain or restore landscapes that have evolved with recurrent fire. Recurrent prescribed fire may be necessary where landscapes cannot be maintained solely with natural fire because of landscape fragmentation caused by road or other development or because of passive fire suppression by livestock grazing occurring outside the park. Prescribed fire may be used to transition a landscape with an unnaturally high fuel loading into a landscape with lower fuel loadings capable of being managed with wildland fire use.

Wildland Fire Use for Resource Benefit (referred to as Wildland Fire Use): Wildland fire use pertains to the No Action Alternative and Alternative 1 where natural ignitions are not immediately suppressed, but are allowed to burn within a predefined area under a set of predefined prescriptions to benefit natural resources as a whole. These fires are allowed to burn with some degree of certainty that the fire will either go out naturally or that fire managers can contain it to predefined areas.

Manual Fuels Reduction: Manual fuels reduction pertains to all alternatives, and is discussed in more detail in the following section. It is, as implied by its name, the removal, reduction, and ultimate restructuring of flammable vegetation or dead and downed wood manually with powered or unpowered hand tools. The exception to the use of hand tools would be the use of tractor- drawn mowers along roads, already part of the routine road maintenance conducted by the park's roads and trails maintenance crew and not a component of the fire management program. Manual fuels reduction is undertaken were the presence of fire poses significant risk to cultural or natural resources, park buildings or infrastructure, or unique areas in the park. It is undertaken to provide a safe environment, or defensible space, for firefighters by moderating fire behavior. Manual fuels reduction would be used in small areas, focusing primarily around the park's developed areas. When necessary, manual fuels reduction may be employed to remove fuels and vegetation from around cultural or natural resources throughout the park.

Appropriate Management Response (AMR): AMR pertains to the No Action Alternative and Alternative 1 and is the process employed when a natural fire start is being considered for wildland fire use and continued throughout the duration of the fire. The spectrum for decision- making following an ignition has broadened under the National Fire Plan (2001) doctrine of AMR. Consideration is given to resource values affected, management goals and objectives, weather, available personnel and equipment, and other NPS regional priorities. Goals and management objectives are determined in advance and stated in the park's fire management plan. Even when all criteria are met however, regional fire activity and limited available personnel may result in suppression of natural ignitions within the park that are excellent candidates for wildland fire use. Under AMR, when all criteria are met, fires are allowed to burn in designated areas and monitored closely in accordance with the Fire Monitoring Handbook (NPS 2003) and the Wildland Fire Situation Analysis decision analysis process. During wildland fire use, the park will continuously update information on fire size, location, behavior, smoke dispersal, safety conditions, and effects.

Elements Common to All Alternatives

Suppression of all unplanned human- caused fires: National Park Service policy requires that all unplanned human starts be suppressed (NPS 1999). Unplanned human- caused fires range from arson, discarded cigarettes, powerline and transformer shorts, unattended campfires, children playing with

matches, and vehicles. Any fire that is not ignited by lightning or intentionally ignited by resource managers must be immediately suppressed.

Monitoring: Monitoring refers to a range of actions that include the collection of information during wildland fire use and prescribed burns and the collection of information on vegetation and cultural resources prior to burning. Where staff resources are available or to meet the burn objectives, monitoring may be carried out at selected intervals after a fire to determine fire effects on particular species or habitats. Specifically, all wildland fire use would be monitored daily or more frequently to ensure compliance with the natural fire zone's prescription parameters, in accordance with the *Fire Monitoring Handbook* (USDI 2003) and the Wildland Fire Situation Analysis. The park would continuously update information on fire size, location, behavior, smoke dispersal, safety conditions, and effects.

The degree to which mitigating measures are effective, particularly when implementing fuels reduction treatments in areas considered vulnerable to high- severity fire, can only be determined if monitoring is being conducted. Any fuels reduction treatment will be monitored, particularly with respect to impacts of the treatment in meeting management objectives: Has enough fuel been removed to reduce fire intensity and severity? And, is the treatment having an adverse impact to any resources that would exceed that of a fire if the site was left untreated? Monitoring would help provide information about when is it advantageous to a population to implement manual fuels reduction and when is it not.

Minimum Impact Suppression Techniques (MIST): Just as AMR guides decision- making for managing fire, MIST guides the choice of tools for managing fire. Wilderness areas in particular are to be managed in ways that minimize human impacts on the resource. Firelines along natural barriers such as talus slopes, bare areas, trails, and roads, will be used whenever possible to minimize disturbance to the landscape and resources. Spike camps will be located where disturbance is minimal and restoration of the site can be readily achieved. Agency resources advisors will be consulted prior to implementing fire management tactics. However, should life or property be in danger, a superintendent has the authority to allow mechanized control and suppression methods.

Manual Fuels Reduction: Reducing fuels and creating firebreaks around property and resources (not in wilderness) requires a degree of precision not always possible with natural or planned ignitions. Manual fuels reduction can include the use of power hand tools when appropriate, such as chainsaws for woody vegetation and dead and downed fuels, and string trimmers and blowers for herbaceous vegetation. These tools can more precisely remove fuels around structures and sensitive areas. Hand-held tools such as handsaws, rakes, shovels, and pruning shears, may be used in wilderness to remove brush near historic sites or unique areas. All types of mechanical and manual thinning are options for reducing brush and fuels around developments.

It must be noted that manual fuels reduction can pose risks to both cultural and natural sensitive resources, particularly from inadvertently trampling or dragging fuels across or placing fuels on top of artifacts or small- stature plants. Thus the risk from these actions must be weighed against the risks posed by fire on a case- by- case basis. If the risks of impacts to sensitive resources cannot be mitigated sufficiently to offset the risk posed by fire and keeping the fire out of an area poses a significant safety risk to firefighters, then it would be appropriate to allow fire to burn over a sensitive site.

Mitigating the impacts from manual fuels reduction could include the presence of resource advisors on site during implementation to provide guidance to firefighters or fuel crews. Resource advisors could locate and flag areas for avoidance where trampling poses a greater threat than that of fire. This would be most necessary during suppression or fire use operations when there is not adequate time to

train fire crews on identifying sensitive resources and the appropriate mitigating tactics. Training could also be provided to firefighters during orientation prior to the fire season or fuels crews prior to implementing fuels reduction treatments to protect sensitive vegetation, unique areas, or cultural sites.

Rehabilitation Measures: Despite AMR and MIST, there may be a need for short- and long- term rehabilitation following fire. Damage to cultural resources from fire are usually permanent and cannot be rehabilitated—timbers burn, glass and metals melt, ceramic cracks, smoke blackens, and the use of water can cause rocks to shatter. Revegetation may be required where handlines where constructed or where soil and native vegetation were disturbed or other erosion control measures to minimize resource damage and other adverse impacts. Staff will consult with specialists (archeologists, hydrologists, plant ecologists, wildlife biologists, and fire ecologists) to determine the needed treatments, then write, implement, and monitor plans to accomplish them.

Mitigation Measures: The park can take actions to prevent or lessen any negative effects of the fire program. Following are expected mitigation actions for each of the impact topics:

- *Impact Topic 1 (Life and Property):*Educate staff and the public about fire prevention, notify the public about pending and on- going activities, take protective measures to minimize the public's exposure, prepare or update cooperative agreements for fire suppression on private lands, reduce hazard fuels manually, construct fire breaks around sites, conduct prescribed burns using natural barriers to keep line construction to a minimum and during less- severe conditions.
- *Impact Topic 2 (Park Neighbors):*Inform neighbors of pending burns, reduce fuels manually to minimize neighbors' exposure, rehabilitate burned areas following unwanted fire on neighboring property, prepare or update cooperative agreements for fire suppression on private lands, coordinate burns with adjacent and nearby land managers, suppress fire adjacent to neighbors with whom the park has no agreement, formulate prescriptions to exclude severe conditions.
- *Impact Topic 3 (Tourism):*When possible, time prescribed burns to avoid periods of high visitation, formulate prescriptions to exclude severe conditions, coordinate burns with adjacent and nearby land managers to minimize cumulative impacts in the region, publicize alternative destinations, use fires as interpretive opportunities to educate the public with respect the fire's natural role on the landscape.
- *Impact Topic 4 (Cultural Resources):*Locate and identify sites vulnerable to fire effects, manually reduce hazardous fuels, construct fire breaks around sites, use minimum impact management techniques, ensure presence of cultural resource experts during fire operations, train fire crews to recognize cultural resources and the appropriate mitigating actions before the onset of the fire season.
- *Impact Topic 5 (Changes in Landscape- Scale Vegetation Patterns):* Reduce fuels in areas of high fuel accumulation that are recognized to be above the range of natural variability, minimize future fire extent by conducting burns to maintain natural mosaic pattern, time fires to minimize intensity and *duration,* use recurrent prescribed fire in a fragmented landscape to mimic the natural role of fire in an intact landscape to maintain or restore historic vegetation patterns.
- *Impact Topic 6 (Wildlife Habitat Change):*Monitor wildlife habitat fire effects, where appropriate suppress and/or reduce fuels in or around unique or fire- susceptible areas, time fires to minimize intensity, use minimum impact management techniques, plan for burning to maintain a natural mosaic pattern, rehabilitate burned areas.

- *Impact Topic 7 (Special- Status Species):*Manually reduce hazard fuels, set prescriptions that protect sensitive species' habitats, ensure the presence of resource experts during fire operations, monitor after fire operations to verify and improve prescriptions. When it is determined that manual fuel reduction is needed, have a resource advisor present to flag areas to avoid trampling or placing fuels on top of or next to sensitive species or their habitat. Fire and fuel crews may also be provided training to recognize sensitive resources assess for treatment and take the appropriate management response.
- *Impact Topic 8 (Exotic Species):*Survey for stand locations, conduct *non- indigenous species* control programs, conduct research programs, reduce fuels around areas containing target species, adjust prescriptions to avoid spread of target species, maintain vigilance about seed transport on vehicles, and educate staff and the public on the effects of the spread of non-indigenous species.

Prescribed Fire Program: Despite the drought- induced reduction in fine fuels observed in recent years, this EA presents a program of prescribed fire for each alternative to allow managers to proceed when conditions are appropriate. Management intentionally ignites prescribed fires in specific areas under predetermined conditions identified in specific burn plans. Most prescribed burns are conducted outside the natural fire season when conditions governing fire spread are less extreme and damage to plants is reduced. Fires occurring during the rainy season are generally constrained by high fuel moisture, high relative humidities, and lower temperatures.

A federally certified prescribed burn boss will supervise appropriate levels of staffing for each prescribed fire under all alternatives. Fire behavior and weather will be monitored during all prescribed fires using the NPS Fire Monitoring Handbook (2003). Annual reviews of prescribed burns allow for fine- tuning prescriptions and lessons learned to be incorporated into future planning.

Fuel Treatment Projects: Table II- 1 (page 25) summarizes fuel treatment projects for 2006 to 2013 for all three proposed alternatives. These projects occur in three of the five fire treatment zones, per Alternative 1. Each treatment zone can be the site of multiple projects.

No Action Alternative: Continue Existing Direction

Management Objective: This alternative continues the current management direction of the 1995 FMP. Analysis of no action, or continuing current management, is required by NEPA.

Fire Program Tools: Suppression, wildland fire use, prescribed fire and manual fuel reduction treatments can be used under this alternative. Natural (lightning) ignitions will be designated wildland fire use if they are in compliance with the prescription parameters in FMU 1. Prescriptions have been developed that balance the costs of burning with the likelihood of fire escape from the unit, as well as threats to human life and property, facilities, cultural resources, sensitive species, or other important resources. If a wildland fire use exceeds prescription and spreads beyond the maximum management area, it would be declared a wildfire as dictated by the appropriate management response. FMU 2 (Conditional Suppression Zone) is shown in Figure II- 1 (page 23) as the area between FMU 1 (Natural Fire Zone) and the park boundary.

FMUs: The existing plan (CCNP 1995) utilizes three FMUs, defined according to safety- related criteria, shown in Figure II- 1. These are the Natural Fire Zone, the Suppression Zone, and the Conditional Suppression Zone.

The Natural Fire Zone (FMU 1) is centered within the park and allows wildland fire use due to its wilderness character and distance from park boundaries. This zone includes small areas at the base of

the escarpment, ridgetops, and the majority of the park's significant canyon drainages, with woodland, grassland and desert scrub communities all represented. Wildland fire use allows for natural ecological processes to shape the structure and function of vegetation in these areas.

The Conditional Suppression Zone (FMU 2) runs along most of the park boundary and is intended as a buffer to protect life and property within and beyond that boundary. Suppression is not automatic; wildland fire use may be applied to a lightning ignition if conditions are acceptable. Criteria for allowing ignitions to burn are more limited than they are for the Natural Fire Zone. All the vegetation communities found in FMU 1 are also found in the Conditional Suppression Zone. Wildland fire use is a management option in this zone, at the discretion of the superintendent. The lower portion of Walnut Canyon is included in this zone due to the higher potential of fires to quickly escape the park and for smoke to negatively impact the residents of Whites City. Most of the FMU's boundary is along the park boundary where strong initial attack and follow- up response are needed to keep fires small and confined. Much of the Conditional Suppression Zone is also designated wilderness; any fires in FMU 2 that are declared wildland fires would be suppressed using the appropriate strategy to minimize impacts of suppression activities on park resources.

Prescribed fire may be used in FMU 2 for fuel reduction, vegetation management purposes, and to create fuel breaks around developments. All prescribed burns will have specific objectives written in the burn plan. The prescription limits for wildland fire use in this zone include those for FMU 1, plus additional limits for rates of fire spread and flame length.

The Full Suppression Zone (FMU 3) represents the remainder of the park and is much smaller in area than FMUs 1 and 2. FMU 3 occurs as four separate units and includes park developments, such as the visitor center, maintenance facilities and residences, as well as areas containing sensitive natural and cultural resources. FMU 3 also includes the area of the park adjacent to Whites City. Fuels would be managed so that fires occurring within the zone could be easily suppressed or of such low intensity that they would not threaten the park infrastructure or sensitive cultural or natural resources.

Prescribed fire is a management tool in this zone for the purposes of fuel reduction or vegetation management. This zone calls for automatic suppression around the park's developed areas and adjacent to Whites City at the east end of the park. Non- fire treatments would take place around sensitive resources, developments, and Rattlesnake Springs.

Fuels treatment projects for the No Action Alternative are illustrated in Figure II- 2 (page 24).

Mitigation Measures and Monitoring: Mitigation measures and monitoring are outlined under *Elements Common to All Alternatives* earlier in this chapter.

Alternative 1: Full Toolbox (Preferred)

Management Objective: Alternative 1 develops a fully integrated FMP that allows resource managers to use all available management tools to meet resource management goals and objectives. These tools include wildland fire use, prescribed fire, suppression, and a limited amount of manual fuels reduction. This alternative includes cooperation with adjoining landowners and ultimately could lead to a regional approach to landscape- level fire management.

Fire Program Tools: All fire program tools are available under this alternative—suppression, wildland fire use, prescribed fire, and manual fuels reduction treatments. Wildland fire use would be excluded from FMU 1, while all techniques may be applied in FMU 2. Under this alternative, the NPS would suppress all unplanned human- caused fires in a manner that causes the least damage to resources, people, and property, using an appropriate management response process. Lightning- ignited fire

Figure II- 1. Arrangements of FMUs under the No Action Alternative

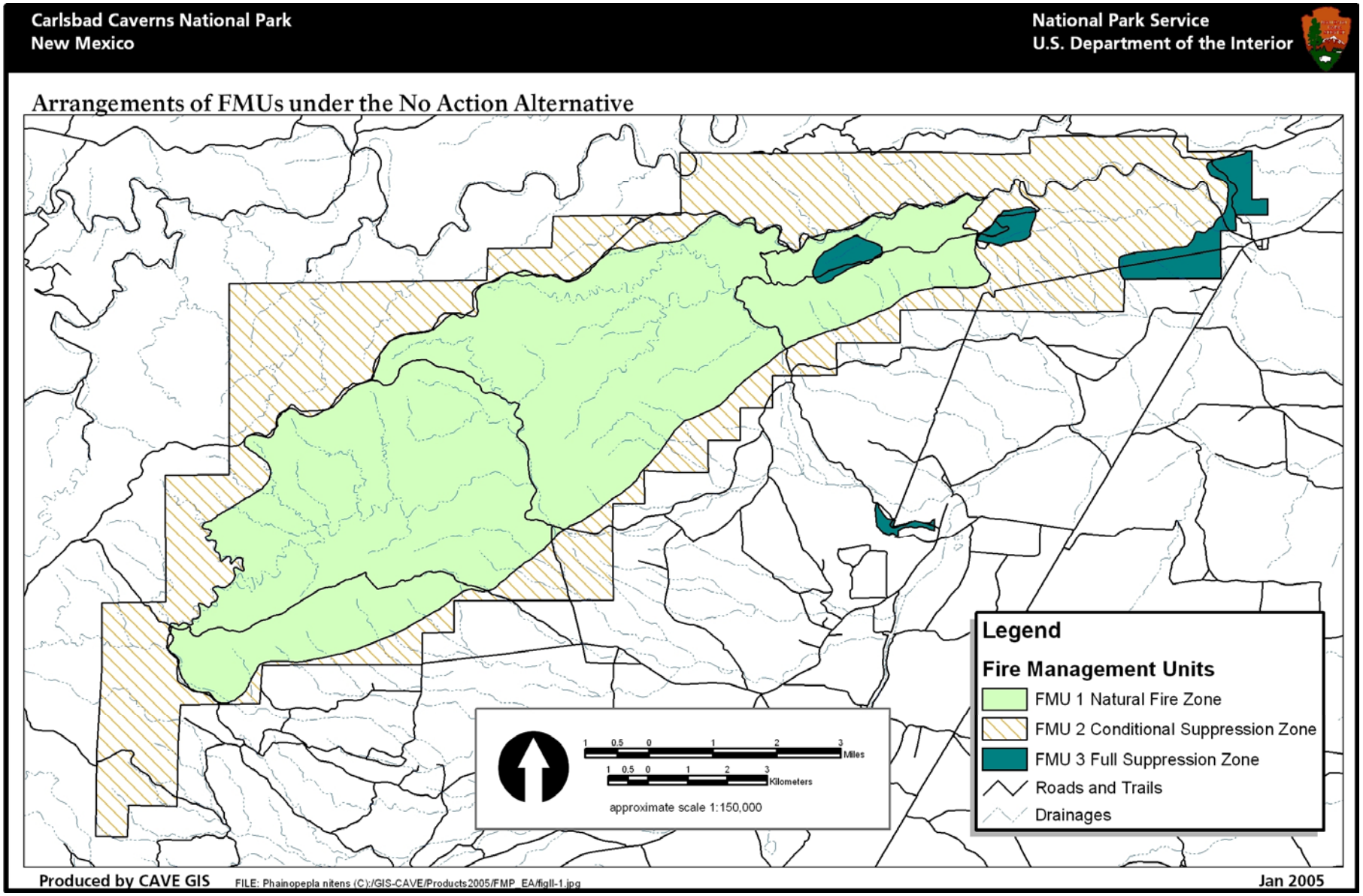


Figure II- 2. Fire projects under the No Action Alternative

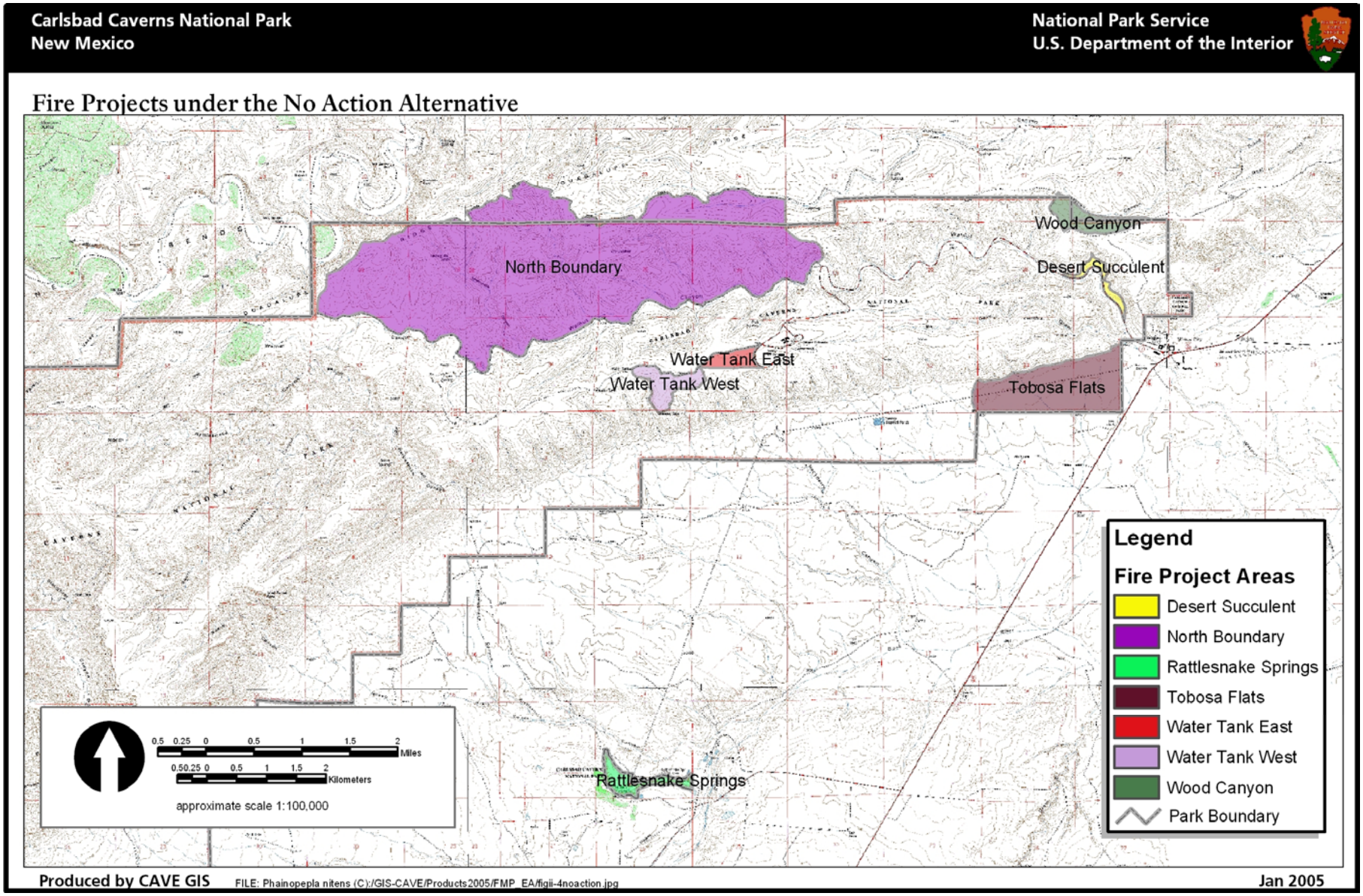


Table II- 1. Fuel treatment projects purposed for the three alternatives: the No Action Alternative and Alternatives 1 and 2. The treatment zone row is a component of Alternative 1.

Project/ Alternatives	Fiscal Year	Treatment	Area (acres)	Vegetation type(s)	Management objectives
Mechanical treatment zone *(87 acres total)*					
Rattlesnake Springs/ No Action, Alts. 1 & 2	2006	Mechanical	87	▪ Woodland riparian	Fuel reduction by removing dead and downed in woodland riparian habitat.
Escarpment prescribed fire zone (6,523 acres total)					
Tobosa Flats/ No Action, Alt. 1	2007	Prescribed burn	481	▪ Creosotebush ▪ Viscid acacia desert shrubland ▪ Tarbush- littleleaf sumac desert shrubland with tobosa grassland ▪ Mariola- skeletonleaf goldeneye desert shrubland ▪ Grama grassland	Maintenance of desert grassland habitat.
Walnut Canyon prescribed fire treatment zone *(10,965 acres)*					
Water Tank East/ No Action, Alts. 1 & 2	2008	Prescribed burn	58	▪ Curlyleaf muhly grassland ▪ Curlyleaf muhly grassland and redberry juniper ▪ Redberry juniper shrubland ▪ Mariola- skeletonleaf goldeneye desert shrubland	Creation of defensible space. A burn plan was prepared for 2000 but not carried out due to drought.
Desert Succulent/ No Action, Alts. 1 & 2	2008	Prescribed burn	42	▪ Mixed arroyo riparian shrubland ▪ Mariola- skeletonleaf goldeneye desert shrubland ▪ Cactus- ocotillo desert succulent shrubland ▪ Curlyleaf muhly grassland	Identify fire effects in high- density *Opuntia* area.
Water Tank West/ No Action, Alts. 1 & 2	2009	Prescribed burn	107	▪ Curlyleaf muhly grassland ▪ Curlyleaf muhly grassland and redberry juniper ▪ Redberry juniper ▪ Shrubland ▪ Mariola- skeletonleaf goldeneye desert shrubland	Creation of defensible space. Area overlaps a prescribed burn conducted in December 1991.
Wood Canyon/ No Action, Alt. 1	2010	Prescribed burn	117	▪ Curlyleaf muhly grassland ▪ Redberry juniper shrubland ▪ Cactus- ocotillo desert succulent shrubland	Multiagency burn to reduce fuels along park boundary. First prescribed burn in 1992.
North Boundary/ No Action, Alt. 1	2012	Prescribed burn	3,636	▪ Curlyleaf muhly grassland ▪ Mariola- skeletonleaf goldeneye desert shrubland ▪ Curlyleaf muhly grassland and redberry juniper ▪ Redberry juniper–oak shrubland ▪ Grama Grassland	Multiagency burn to reduce fuels along park boundary. First prescribed burn in 1995.

No Action Alternative: All projects would be carried out in appropriate conditions and seasons. ***Alternative 1:*** All projects would be carried out in appropriate conditions and seasons. ***Alternative 2:*** Only projects at Rattlesnake Springs, Water Tank East, Desert Succulent, and Water Tank West would be undertaken.

would be permitted to burn under predetermined conditions that preclude significant threats to human life, property, facilities, cultural resources, listed species, or any other important identified resource. Monitoring will be carried out according to guidelines from the Fire Effects Handbook (USDI 2003).

FMUs: There are two FMUs under this alternative, delineated primarily by whether or not wildland fire use is available for implementation (Figure 11- 3, page 27). Alternative 1 delineates a small area that excludes wildland fire use fires and designates a full suppression unit (FMU 1) around park developments such as the park headquarters, Rattlesnake Springs, and an area adjacent to White's City in the extreme eastern part of the park. This FMU allows suppression, manual fuels reduction, and prescribed fire to manage fire, fuels, and vegetation. This FMU was delineated to address the susceptibility of private and public property and residents to wildland fire and smoke. All unplanned fires—human- or lightning- caused—would be suppressed to protect developments and provide for the safety of park visitors and staff. The park would use manual fuels reduction to reduce fuel loading immediately around structures and other infrastructure within this unit. Prescribed fire may also be used to reduce fuels or manage vegetation. FMU 1 encompasses primarily grassland, desert shrubland, and riparian woodland communities.

The remainder of the park is delineated as FMU 2, where wildland fire use is an available tool in addition to the tools available in FMU 1. Although manual fuels reduction is an option, it would be used on a limited basis, primarily to remove fuel from around sensitive cultural and natural resources. Wildland fire use would be considered for implementation when conditions are within prescription and other criteria are met (see *Appropriate Management Response* section). In contrast to the No Action Alternative, which delineated a conditional suppression FMU to serve as a buffer between the park's interior and its boundary, this Full Toolbox alternative would include this buffer as part of FMU 2. It is believed that equivalent results can be achieved with the appropriate management response as the "conditional suppression" FMU was intended in the No Action Alternative. FMU 2 also specifies protection measures for special features such as habitat of threatened and endangered species. This FMU contains all the vegetation communities found at Carlsbad Caverns (see Chapter III for full descriptions) and includes most of the park's designated wilderness. Protection measures would be required for sensitive natural and cultural resources in FMU 2. Fewer sites requiring protection are present in this unit than in FMU 1, but among them are the Putnam Cabin radio repeater and numerous Apache and pre- Apache work sites.

Figure II- 4 (page 28) shows the five treatment zones for Alternative 1, two in FMU 1 and three in FMU 2. Each zone would emphasize different tools to achieve fire, fuel, and resource management objectives. Within FMU 1, prescribed fire would be used to manage fuels in zones immediately to the east and west of park headquarters. Manual fuels reduction and suppression would be used exclusively in the two remaining zones, one at park headquarters and one at Rattlesnake Springs. The vegetation within the zones near the park headquarters is primarily grassland with a significant redberry (Pinchot) juniper component, and the vegetation at Rattlesnake Springs is primarily riparian woodland.

Within FMU 2, the wildland fire use study zone where most of the park's woodlands and forest occur, wildland fire use would be the primary tool to manage vegetation and fuels. This zone lies between the base of the Guadalupe escarpment and the park's northern boundary and west from Rattlesnake Canyon's eastern edge to the park's western boundary. While prescribed fire is available for use, most of the area west of Slaughter Canyon has burned in the last 35 years, which is within the natural fire

Figure II- 3. Arrangements of FMUs under Alternative 1 (Preferred Alternative)

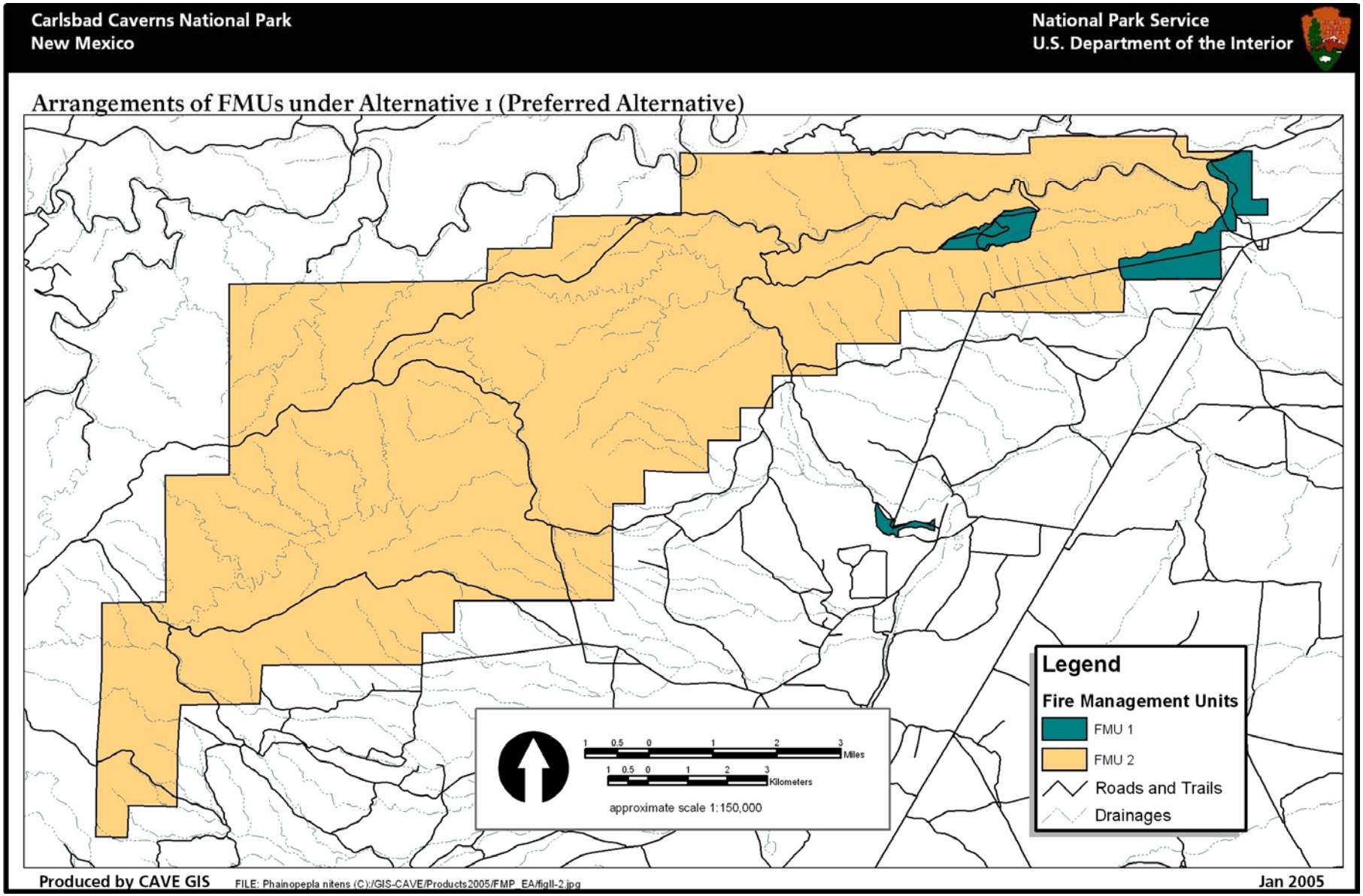


Figure II- 4. Fire Treatment Zones under Alternative 1

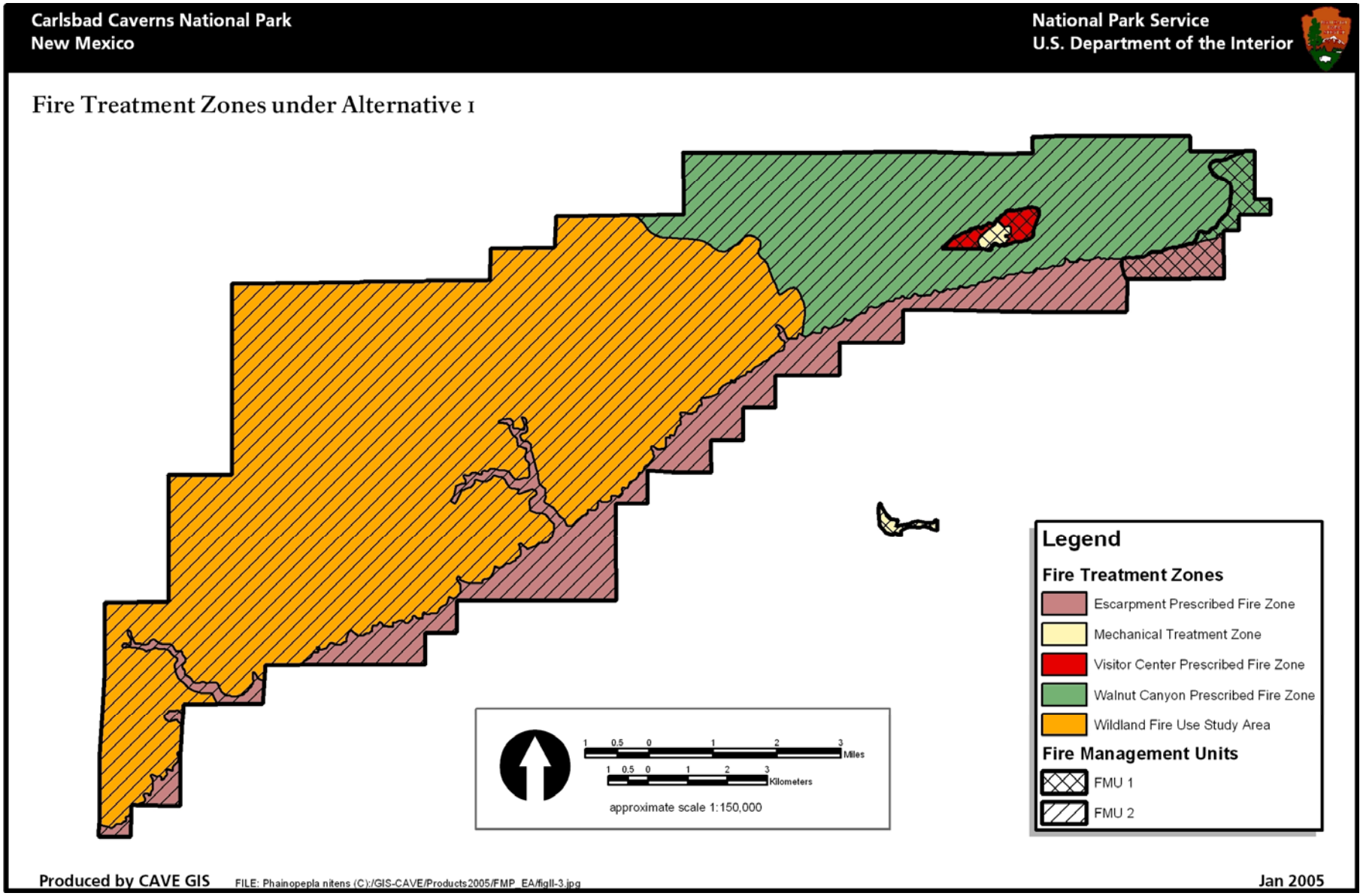
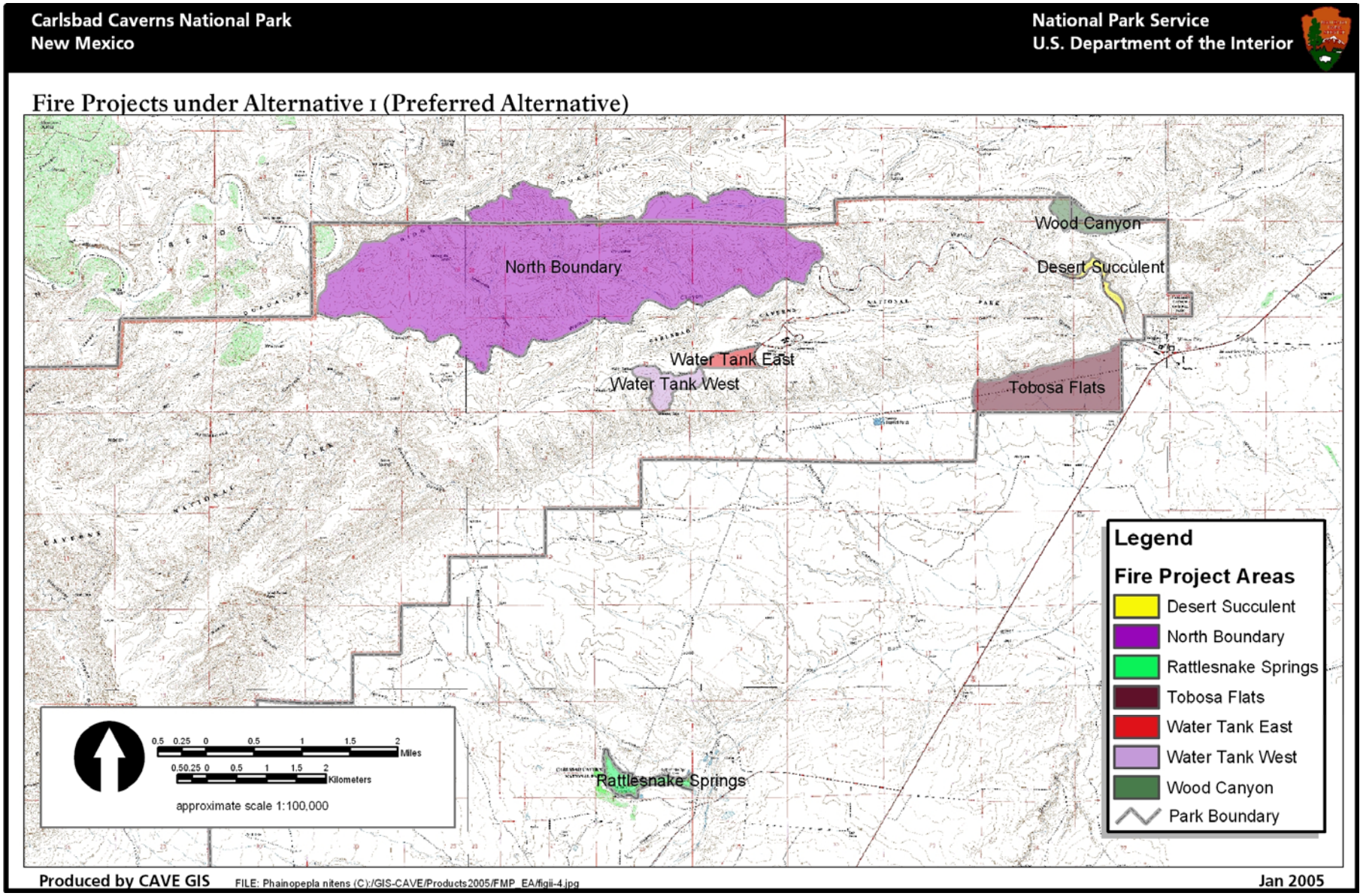


Figure II- 5. Fire Projects under Alternative 1 (Preferred Alternative)



regime, and fuel loading should be within the range of natural variability. While fire has been conspicuously absent in the recent past between Slaughter and Rattlesnake Canyons, wildland fire use, at least in the short term, may be sufficient to manage vegetation in this area.

In the Walnut Canyon zone (east of Rattlesnake Canyon and extending to the park's eastern boundary, and between the base of the Guadalupe escarpment to the south and the park's northern boundary), both prescribed fire and wildland fire use can be used to reduce fuels or manage vegetation. Because of the proximity of Whites City, the extreme eastern end of the park is delineated as FMU 1, which does not permit wildland fire use fires. Within this zone a significant amount of the area, particularly west of park headquarters and the visitor center and along the northern boundary, has been burned with prescribed fire over the last 15 years, placing these areas within the range of natural fire occurrence. For the area west of the visitor center and park headquarters it is anticipated that, at least in the short term, it may be an area that can adequately be managed with wildland fire use. Because of concerns of fire spreading beyond the park's northern boundary, prescribed fire would be used there and along the eastern boundary to provide defensible space and provide the park greater flexibility in implementing wildland fire use in the interior of the park to the west and south. Prescribed fire may also be used in some areas within the zone to reduce fuels before allowing wildland fire use to occur. The vegetation within this zone is comprised of grassland with redberry juniper, desert shrubland, and arroyo shrublands and woodlands.

In the Escarpment Prescribed Fire Zone, which runs along the southern boundary of the park to the base of the Guadalupe Escarpment, prescribed fire may play a significant role in the management of vegetation. Historically most of the fires that occurred here most likely originated on the plains outside the park boundary to the south. Under current conditions and land use practices, the potential for fires starting outside and spreading into the park has been greatly diminished primarily as a result of landscape fragmentation by road and highway development and livestock grazing. Thus the potential for wildland fire use to maintain or restore vegetation communities within this zone may be limited and application of recurrent prescribed fire may be necessary to play the historical role of natural fire. Most of the vegetation within this zone is desert shrubland and grassland.

Fuels treatment projects for Alternative 1 are illustrated in Figure II- 5 (page 29).

Mitigation Measures: Mitigation measures are outlined under *Elements Common to All Alternatives* in earlier in this chapter.

Alternative 2: Limited Prescribed Fire

Management Objective: In Alternative 2, safety and conservation of resources are the highest priorities and are accomplished through containment of fire. Fire containment is an indirect suppression tactic that utilizes existing barriers, natural or manmade, that may include rock escarpment, exposed bed rock, denuded areas or roads, trails, and parking lots, to restrict fire to a specific area. This alternative does not allow wildland fire use as a management tool. A significant amount of the park has burned in the last 20 to 35 years with either prescribed fire or wild fires so that for the five- year period this fire management plan would be in effect, this would be a reasonable alternative. At the end of the five- year period, the fire management plan would need to be reevaluated. If changes were warranted, then a new planning process would be initiated. Conservative use of prescribed fire for fuels management or research is an option, but only under conditions that limit risk of escape to the fullest extent possible. Some mechanical fuel reduction is used to protect park developments, sensitive resources, and the park boundary.

Fire Program Tools: Suppression, prescribed fire, and mechanical fuels reduction are management options in all areas of the park, although the on- going drought may preclude the need for burning for a number of years. Prescribed fire may be used for the purposes of fuel reduction, research, or vegetation management. Prescribed fires would provide the best safeguard against a fire escaping park boundaries, as well as for protection of human life, property, facilities, cultural resources, threatened and endangered species, or any other important identified resource. Extensive manual thinning of fuels would be required to limit fire escape. The only opportunity for reducing fuel fuels would be in the event of an unplanned fire start. Suppression action would be immediately initiated and, if no resources are immediately threatened, control- contain tactics would be employed to manage the fire within the park.

FMUs: Only one FMU is defined under Alternative 2 (Figure II- 6, page 32), because fire management strategy would not differ for any area of the park. This FMU includes all park vegetation communities, designated wilderness, park developments, and sensitive natural and cultural resource areas. All unplanned ignitions would be suppressed/contained. Suppression would be conducted in a manner that causes the least damage to resources, people and property. In designated wilderness, suppression activities would meet the *minimum requirement* concept that calls for the least intrusive methods of completing necessary tasks, such as the use of hand tools rather than power tools.

Under this alternative, only fuels treatment projects Rattlesnake Springs, Water Tank East, Desert Succulent and Water Tank West from the list in Table II- 1 would be proposed (Figure II- 7, page 33).

Mitigation Measures and Monitoring: Mitigation measures for Alternative 2 are the same as for the No Action Alternative, except for tourism (Impact Topic 3). With limited prescribed burning, fire activities are reduced which minimizes tourism impacts. Monitoring would take place as described earlier in this chapter.

Alternatives Considered but Eliminated from Detailed Evaluation

Research Prescribed Fire/Wildland Fire Use

This alternative—one that restricts the use of prescribed fire—is based on the argument that not enough is known about fire effects on the park's ecosystems. Under this alternative the park would be divided into three FMUs similar to those under the No Action Alternative (CCNP 1995): a wildland fire use unit in the park's interior, a conditional suppression unit out to park boundaries, and a full suppression unit around developments and along the eastern boundary. Wildland fire use would be permitted in the wildland fire use and conditional suppression FMUs when natural ignitions look like they could satisfy management prescriptions based on safety and resource protection needs. Prescribed fire would not be an option for fire management, except for the purposes of research. Research fire would be allowed in all units. The research results would be used to update the management plan to reflect increased understanding of fire's role in the park's vegetative communities. Cooperation with neighboring agencies is also a feature of this alternative, as are non-fire fuel treatments around developments, the Rattlesnake Springs area, and selected sensitive resources.

Reason for dismissal: This alternative recognizes that our understanding of fire's role in Chihuahuan Desert scrub communities is incomplete. However, prescribed burning is an extremely useful tool for reducing hazardous fuels and achieving structural goals for vegetation communities. Limiting prescribed burning under this alternative would remove an important strategy for preventing high-severity wildland fire and the escape of such fire from the park. Substituting mechanical thinning is not feasible in all problem fuel areas, as thinning results in slash piles that need to be burned.

Figure II- 6. Arrangements of FMUs under Alternative 2

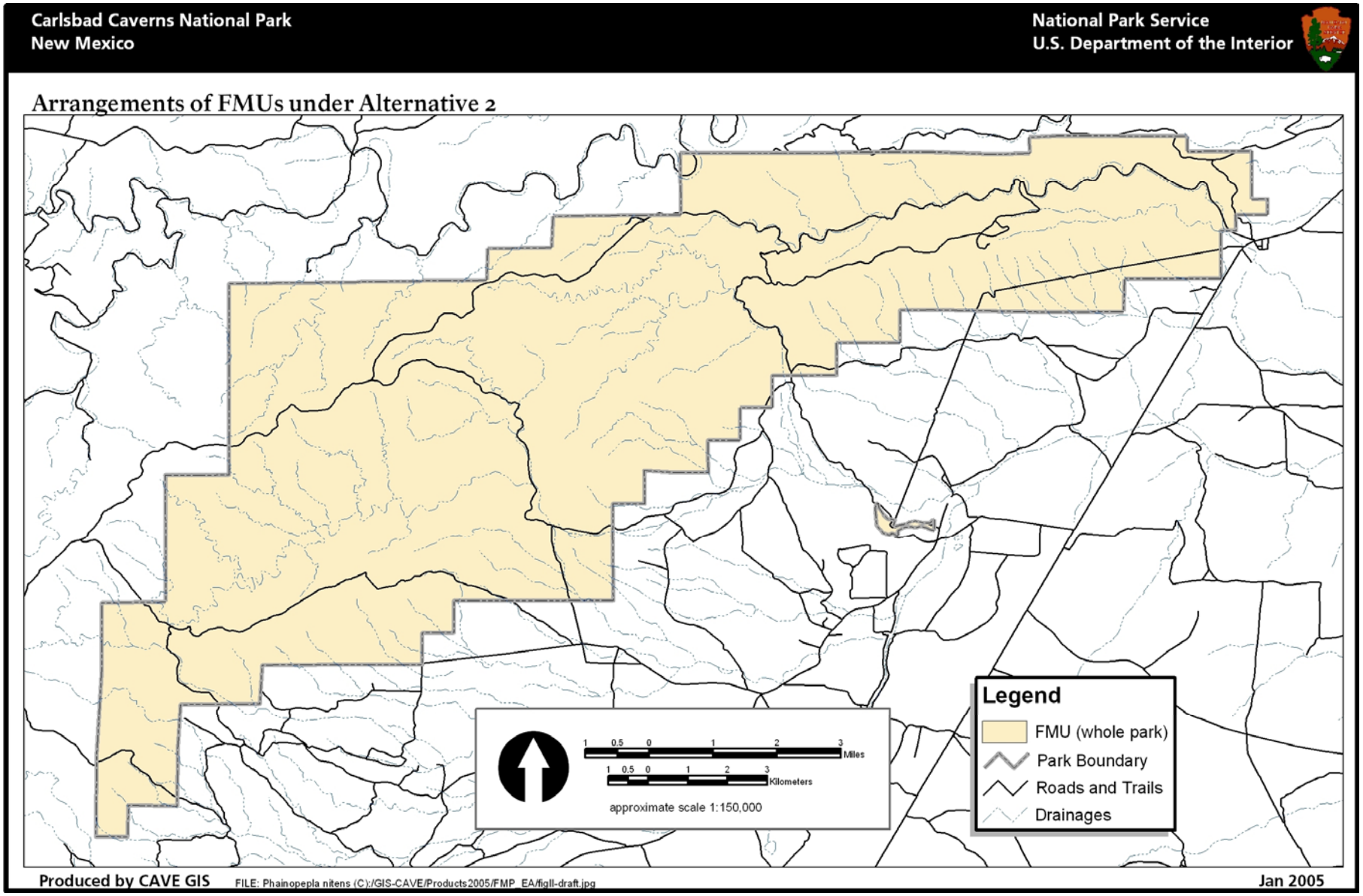
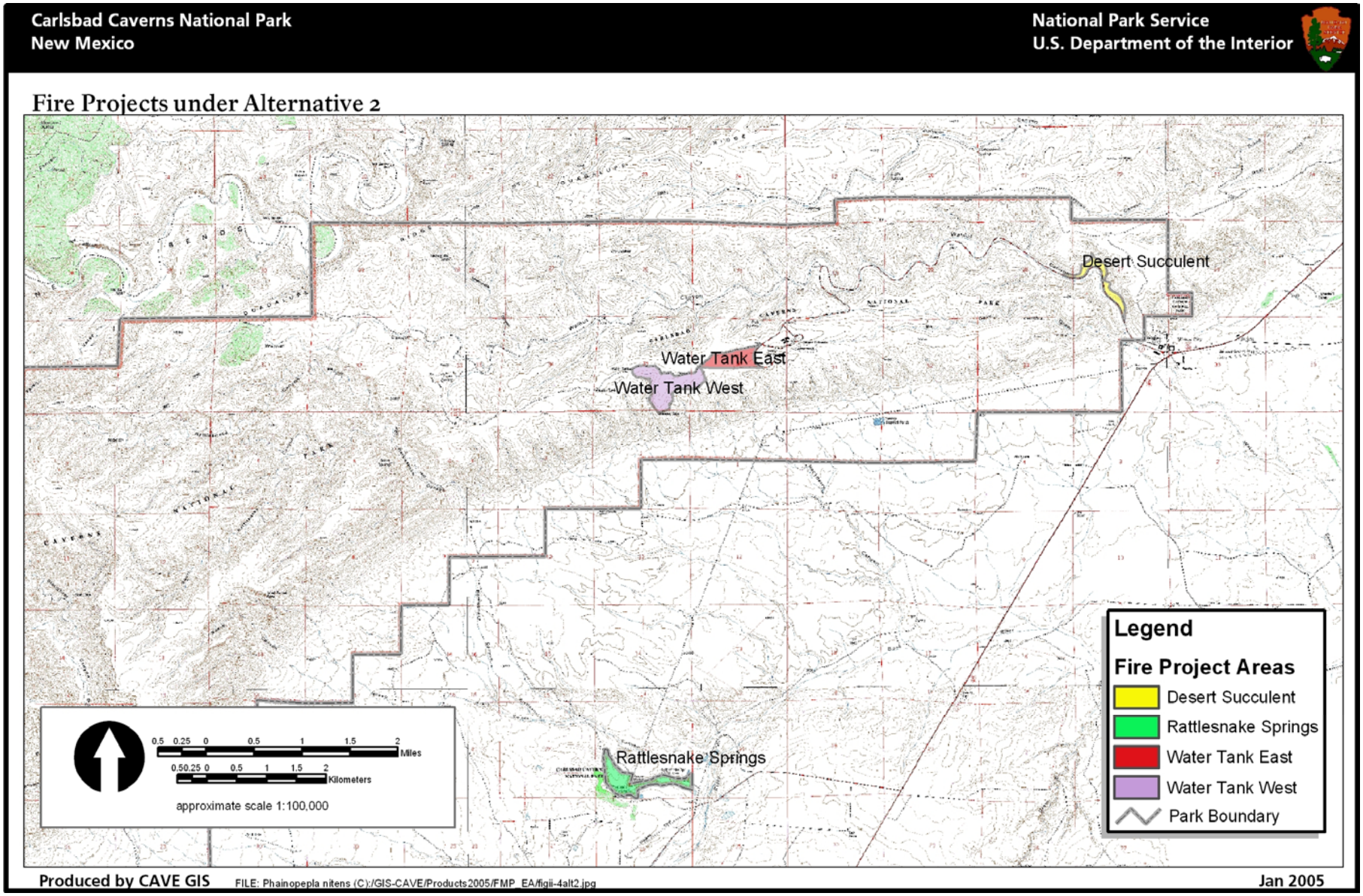


Figure II- 7. Fire Projects under Alternative 2



Full Fire Use

If the long- term health of Carlsbad Caverns' plant communities is to be assured, it can be argued that reestablishing and maintaining fire as a dominant factor in ecosystem function is necessary. This alternative allows all naturally ignited fires to burn within the park; prescribed fire for fuel reduction and resource benefit; and non- fire fuel treatments around sensitive resources, developments, and the Rattlesnake Springs area. Because the preservation of life and property is the number one priority for fire management operations, this alternative protects individual features and structures with small buffer zones and otherwise permits fires to burn unless conditions are unsafe. Fires would be suppressed at the park boundary.

Reason for dismissal: Administrative considerations decrease the attractiveness of this alternative. Deciding whether to fight fires burning very close to places that require protection on a case- by- case basis would be prohibitively complicated and time- consuming. In inhabited areas, there is no safety margin for sudden changes in fire conditions.

Environmentally Preferred Alternative

The environmentally preferable alternative is defined as "the alternative that will promote the national environmental policy as expressed in the NEPA's Section 101. Ordinarily, this means the alternative that causes the least damage to the biological and physical environment; it also means the alternative which best protects, preserves, and enhances historic, cultural, and natural resources" (CEQ 1981). While Alternative 2 is reasonable and would allow the park to meet the its fire, fuels, and resource management goals and objectives, it is most effective over the five years that the proposed fire management plan is in effect and at the end of that period would need to be reassessed. If changes are needed, such as making wildland fire use a viable option for managing the parks vegetation or fuels, a new planning process would need to be initiated to allow that to occur. Both the No Action Alternative and Alternative 1 also meet the fire, fuels, and resource management goals and objectives, however they are both more viable than Alternative 2 beyond the five- year period the proposed FMP would be in effect. The No Action Alternative and Alternative 1 would be more adaptable to changing conditions over the long- term and provide a better frame work for adaptive management. The No Action Alternative, however, is more limiting than Alternative 1 because of the Conditional Suppression Zone that buffers the park's boundary from its interior. This zone places constraints on the implementation of wildland fire use within this zone that may not be warranted at the time of a natural ignition. Alternative 1 removes this conditional suppression zone, thus providing greater flexibility over the No Action Alternative in implementing wildland fire use through the AMR process. Therefore, meeting the goals and objectives of the fire management plan within the next five years and beyond is best met by Alternative 1.

NEPA Sections 101 and 102

The goals characterizing the environmentally preferable condition are described in NEPA Section 101. Section 101 states that "...it is the continuing responsibility of the Federal Government to …(1) fulfill the responsibilities of each generation as trustee of the environment for succeeding generations; (2) assure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings; (3) attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences; (4) preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity, and variety of individual choice; (5) achieve a balance between population and resource use which would permit high standards of living and a wide sharing of life's

amenities; and (6) enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources."

Using the above criteria, it has been determined that the environmentally preferred alternative is Alternative 1. This alternative surpasses the other alternatives in best realizing the full range of national environmental policy goals as stated in NEPA Section 101. Although the other alternatives may achieve greater levels of protection for specific resources, or minimize impacts to visitor experience, Alternative 1 provides the best overall balance of options for managing fire at Carlsbad Caverns. It provides park resource managers with the full range of fire management tools and decision- making flexibility thereby allowing them to best balance natural and cultural resource management needs with safety and other concerns. Alternative 1 also involves the most interagency coordination.

Chapters III and IV of this EA present the analysis to justify selection of Alternative 1 in accordance with the guidelines set forth in NEPA Section 102.

Summary of Reasonable Alternatives

Appendix E summarizes important features of each retained alternative and the degree to which the alternatives meet FMP purpose, need, goals, and objectives. Each of the retained alternatives contains a different mixture of the same elements: suppression, prescribed fire, and wildland fire use for resource benefit. The amount of each fire strategy depends on weather and chance ignitions. It is the assumption of the IDT that Alternative 2 (Limited Prescribed Fire), the No Action Alternative, and Alternative 1 (Full Toolbox), in that order, move from causing the fewest short- term direct adverse effects and fewest long- term direct and indirect benefits to causing the most short- term direct adverse effects and most long- term benefits. Impacts are analyzed in detail in Chapter IV.

Two kinds of irreversible impacts are possible under all the alternatives: (1) loss of historic structures to fire, and (2) very long- term ecological change with high- severity, and ultimately stand- replacing, fires. All alternatives provide for regular mechanical thinning around historic structures and developments to avoid the former, and Alternative 1 is predicted to best avoid adverse impacts of high- severity wildland fires, followed by the No Action Alternative, and finally Alternative 2.

Chapter III: Affected Environment

Chapter III describes the environment potentially affected by the alternatives being considered. This description provides information necessary to understand the effects of the alternatives that are presented in Chapter IV.

Carlsbad Caverns National Park sits on the eastern end of the Guadalupe Mountains, in Eddy County, New Mexico, just north of the Texas state line. An escarpment that runs the park's 21- mile length generally defines the southern edge of the park. Elevation in the park ranges from 3,595 feet at the base of the escarpment to 6,520 feet in the extreme western end of the park. The elevation along the escarpment decreases from west to east. Elevation at the visitor center is about 4,400 feet.

Slopes below the escarpment are generally less than 10 percent. The remainder of the park, particularly the western portion, consists of a maze of steep, narrow canyons where slopes often exceed 70 percent with numerous cliffs. *Watersheds* drain primarily south and east from Guadalupe Ridge, which crosses the northwest corner of the park parallel to the escarpment. The small area of the park north of Guadalupe Ridge drains to the northwest.

More than 20 permanent springs and seeps occur within the park. Surface water is otherwise scarce, and riparian areas are limited to a few places along normally dry washes. The largest spring, Rattlesnake Springs, flows at a rate of more than 1,000 gallons per minute and supports a significant riparian community. The spring also supplies water for human use in the developed areas in and around the park. Ephemeral pools in several canyons are also an important source of water for the park's wildlife.

The 46,766- acre park is considered one of the few protected portions of the northern Chihuahuan Desert. Caves are the park's main attraction, and aboveground features are of interest to a smaller subset of visitors and researchers. The park contains designated wilderness (33,125 acres) within its boundary. Desert scrub and grassland plant communities dominate the park landscape. Small pockets of coniferous woodland are found at higher elevations in the western third of the park. The climate is temperate and arid, characterized by warm summers and mild winters. Table III- 1 (page 38) displays annual rainfall and temperature data.

Impact Topic 1 (Life and Property)

Figure III- 1 (page 38) displays roads and other park developments. The public has access to approximately 7 miles of paved road and 14 miles of unpaved road in the park. There are 44 miles of designated and signed trails, 4 trailheads (Juniper Ridge, Yucca Canyon, Slaughter Canyon and Rattlesnake Canyon), and 2 picnic areas. Developed sites include the visitor center and Rattlesnake Springs. Facilities located at these sites, including park maintenance facilities and housing, comprise a significant component of the visitor facilities in the park. Other developments within the park include the water treatment and distribution system, several radio repeaters, including Putnam Cabin, and numerous archeological and historic sites, such as Lowe Ranch. Most of the park is undeveloped, and a majority is designated as wilderness.

Wilderness designation necessitates minimum impact management. However, during an emergency, the protection of life and property may supersede the maintenance of wilderness values, and the superintendent may authorize mechanized equipment use in the backcountry.

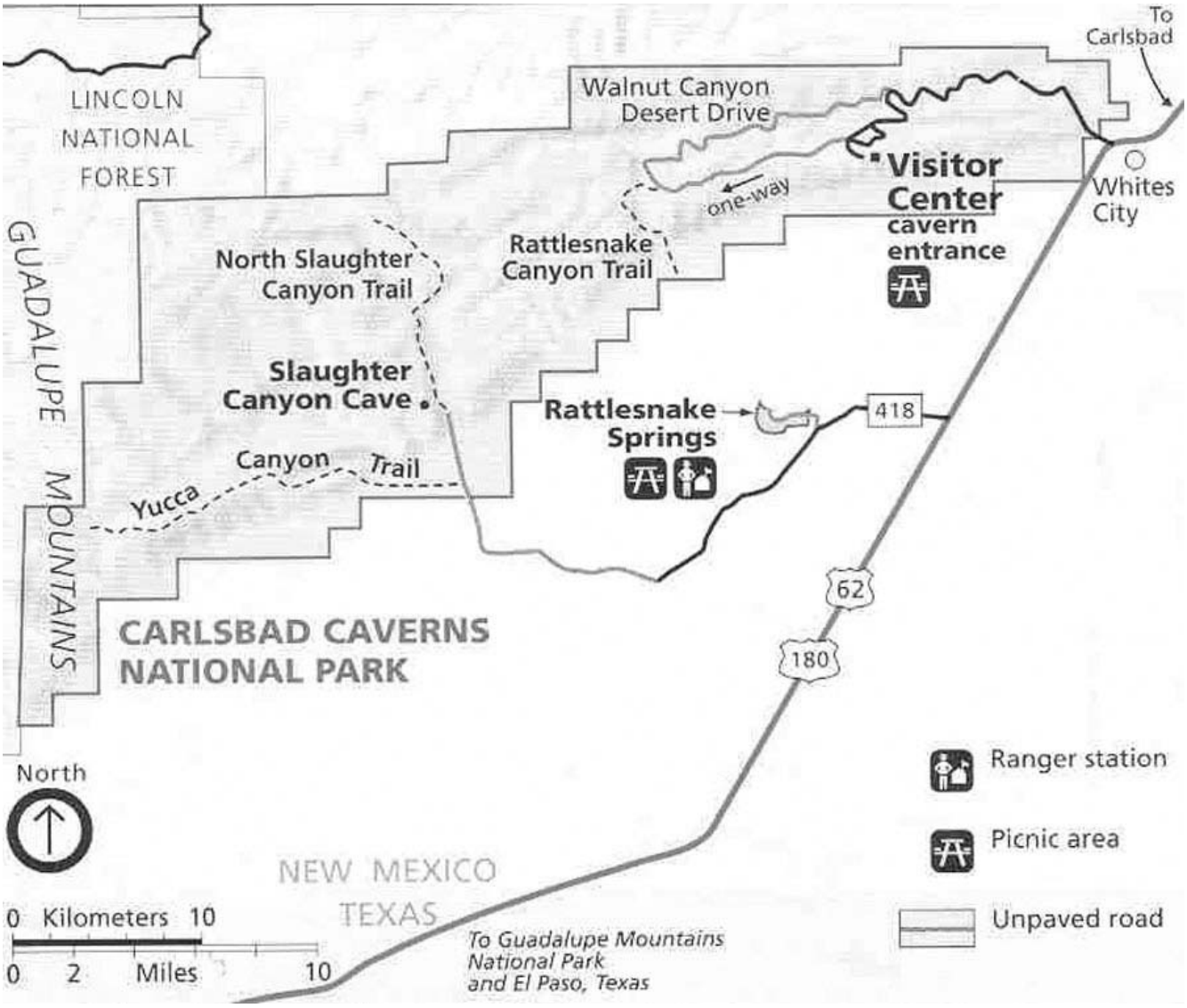
All backpackers receiving permits are advised by park staff at the visitor center of fire danger conditions.

Table III- 1. Monthly Climate Summary for Carlsbad Caverns National Park, New Mexico, 1930- 2000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max Temperature (°C)	13.6	16.0	19.5	24.6	28.7	32.8	33.0	31.9	28.7	24.0	18.2	14.4	23.7
Average Min Temperature (°C)	0.9	2.6	5.4	9.8	14.4	18.1	19.2	18.8	15.8	11.3	5.4	1.8	15.9
Average Total Precipitation (mm)	12.4	10.9	9.1	15.7	37.1	46.5	50.3	60.2	75.4	36.1	11.9	13.0	378.7

Source: Western Regional Climate Center (2001).

Figure III- 1. Carlsbad Caverns National Park area



Impact Topic 2 (Park Neighbors)

Carlsbad Caverns National Park lies wholly within Eddy County, New Mexico, and is surrounded by federal, state and private lands (Figure III- 2, page 40). About 39 percent of the perimeter of Carlsbad Caverns National Park abuts BLM lands, 25 percent private land, 21 percent Lincoln National Forest, and 15 percent New Mexico state lands. In 1934, the park acquired Rattlesnake Springs, which is outside the main body of the park, approximately six miles southwest of the visitor center. This land is surrounded by private property.

The town of Whites City sits at the eastern edge of the park. The city of Carlsbad is approximately 20 miles northeast of Whites City on US Highway 62/180. Carlsbad is a major community of southeast New Mexico, and offers numerous services for the region. The remainder of the region surrounding the park is sparsely populated and includes the rural communities of Loving, Queen and Malaga.

Lands managed by the BLM's Carlsbad Field Office comprise much of the region's real estate. BLM lands are managed according to the principle of multiple use/sustained yield (recreation, timber, minerals, watershed, fish and wildlife, wilderness). The BLM issues permits for private energy firms to develop natural gas and oil deposits on its lands. Other activities on BLM lands adjacent to the park include livestock grazing and recreation.

The Lincoln National Forest's Guadalupe Ranger District borders the park to the west and northwest. The forest is managed under multiple use/sustained yield principles. Traditional and current forest uses include horseback riding, recreational vehicle use, hiking, camping, hunting, birding, woodcutting, shooting, and mountain biking. Several backcountry trails on the district cross into the park (Ussery, Guadalupe Ridge and Yucca Canyon trails).

New Mexico state lands are managed for the benefit of the state's citizens and to maximize income to state agencies. State lands are generally scattered in a checkerboard pattern among BLM and private lands. Leasing for oil and gas production and grazing provide important revenue in the region around the park, and maximizing revenues is a major goal. This goal can pose a conflict with the resource management goals of other agencies.

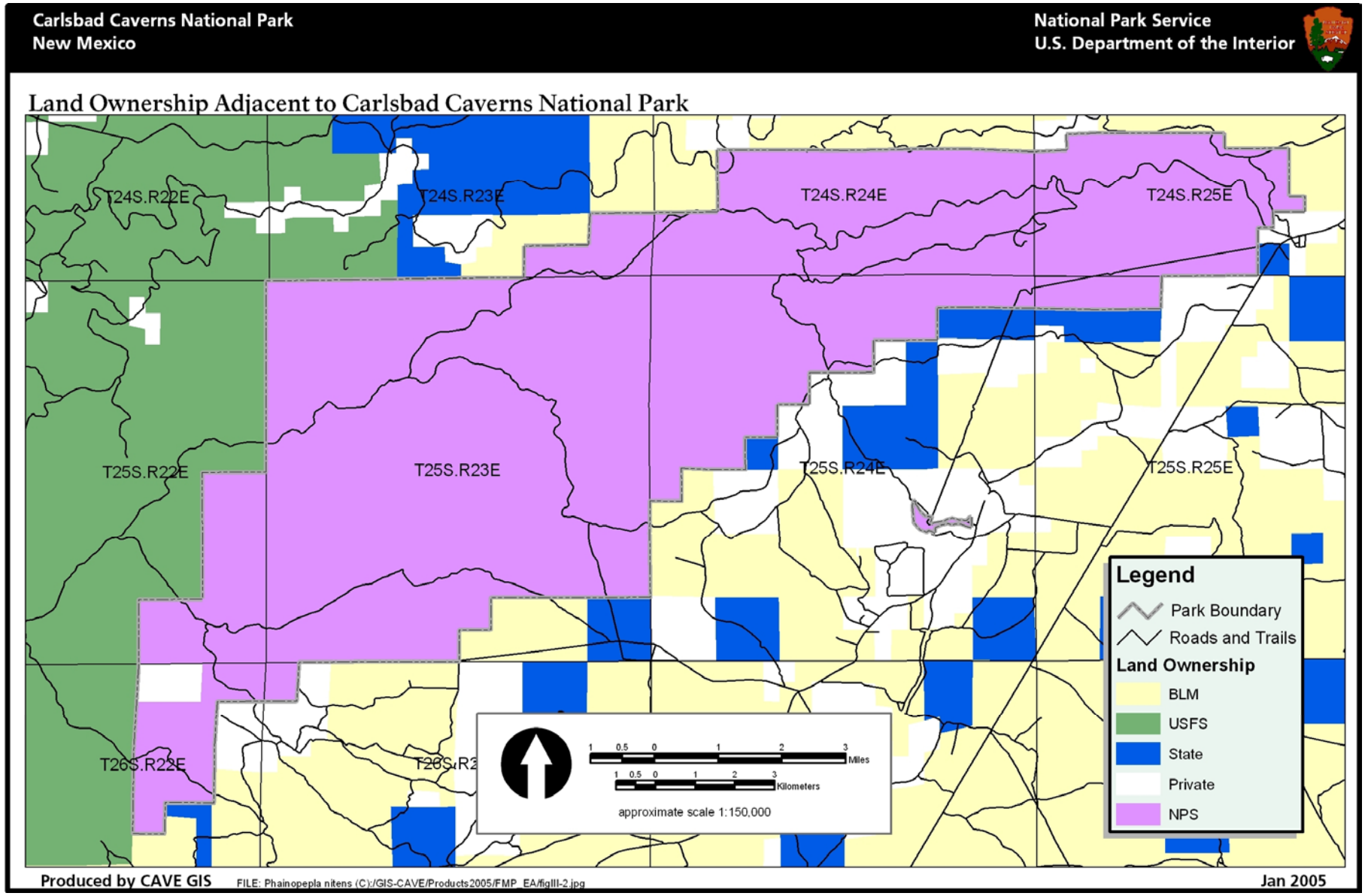
Rattlesnake Springs is bordered by the privately owned Washington Ranch and other private lands, as well as land owned by The Nature Conservancy. The Nature Conservancy lands are used to protect the habitat of various native species, especially wetland species. In 1984, the NPS and The Nature Conservancy entered into a memorandum of understanding to protect stream and wetland habitat and to preclude uses or activities that would threaten native flora and fauna (CCNP 1996).

The park has mutual aid agreements with all adjacent federal land management agencies, the State of New Mexico, and neighboring Whites City. Through the agreement, the Whites City Volunteer Fire Department may provide first response assistance for structural and wildland fires in the park. Likewise, the NPS provides first response assistance to any fire in the area covered by the agreement. Fire dispatch services for wildland fire ignitions at Carlsbad Caverns are provided by the Lincoln National Forest dispatch office in Alamogordo upon request.

Impact Topic 3 (Tourism)

Park visitation averages 500,000 people every year. Carlsbad Cavern tours are by far the most significant activity in the park, but other activities include caving, hiking, overnight backpacking, birding, and nature study. Surface visitor use is largely concentrated in Walnut Canyon. May through October is the peak visitor season. Rattlesnake Springs and Slaughter Canyon, which can be visited on

Figure III- 2. Land Ownership Adjacent to Carlsbad Caverns National Park



Numerous other recreational attractions exist in the region. Guadalupe Mountains National Park is 55 miles southwest of Carlsbad, New Mexico, just across the state line in Texas. Camping, backpacking, day hiking, picnicking, and ranger- guided walks and talks are the primary visitor activities. Eighty miles of trails access the desert, canyons, and highlands of the park.

The Lincoln National Forest provides numerous opportunities for outdoor recreation. Two major attractions on the forest readily accessible by improved road include Sitting Bull Falls picnic area and Five Points Vista. The Living Desert Zoo and Gardens State Park just to the northwest of Carlsbad exhibit the flora and fauna of the Chihuahuan Desert. Brantley Lake State Park, 12 miles north of Carlsbad, has a picnic area, beach, and two boat ramps. Sport fishing is a popular activity.

Tourism has long been important to the local economy. In 2002, park and visitor spending supported 1,000 jobs (or 4 percent of total employment) in Eddy County. In that same year, park visitors spent $31 million in Eddy County. The city of Carlsbad offers a substantial base of tourist accommodations for the thousands of park visitors who come each year. Whites City is also an important provider of lodging, food, and souvenirs for park visitors. Park visitors account for half of total room nights and hotel sales and 44 percent of all tourists spending in the county (Michigan State University 2004).

Carlsbad provides a full range of facilities and services for travelers who visit Carlsbad Caverns and other local attractions. More than 20 motels provide over 1,000 rooms. In addition, there are three commercial campgrounds near Carlsbad.

Whites City is oriented toward park visitors and hosts an array of services and facilities. The small community has two motels, including the 62- room Cavern Inn and the 42- room Guadalupe Inn. Camping is provided at a 106- site recreational vehicle park and an associated tent camping area with 25 campsites. Two restaurants, a grocery store, museum, gift shop, and a US post office accompany the lodging facilities. In addition, there is a water amusement park.

Resource extraction and agriculture are other important sectors of Carlsbad's economy. Carlsbad is the center for the largest potash mining operations in the United States. Potash is used as fertilizer and as a chemical in specialty and industrial markets. In 2000, the Carlsbad potash district provided more than 70 percent of total potash sales among US producers, or about $192 million. Employment in the Carlsbad potash industry totaled 1,060 people, with an industry payroll of $66 million. Oil and gas is another major segment of the resource industry.

In 2001, New Mexico ranked sixth in crude oil production and second in natural gas production among producing states. In that year, Eddy County ranked second in oil production and third in natural gas production among New Mexico counties, according to the New Mexico Energy, Minerals and Natural Resources Department.

Impact Topic 4 (Cultural Resources)

Human use of the Carlsbad area dates back to at least 8,000 B.C. Some of the pictographs in the park, as well as remains of foodstuffs, household items, tools and weapons, have been associated with early peoples. The Late Prehistoric or Ceramic Period, approximately A.D. 750 to 1450, was an active time for human use and occupation of the region. People occupying the area at the time left lithic and ceramic scatters, sites in caves, ring middens, open campsites, and possible habitation sites and villages. By the mid- 1700s, the Mescalero Apache hunted game and raised corn in the flatlands, retiring to stream drainages in the Guadalupe and adjacent mountains in the summer. In the mountains, the Apaches constructed semi- permanent rancheria villages and corrals for their horses.

Several other groups including Zia Pueblo, Isleta Pueblo, Hopi, and Comanche have oral traditions telling of specific places within the park.

Early Spanish explorers traversed the area during the sixteenth and seventeenth centuries. In the late 1700s and early 1800s, Spanish and later Mexican soldiers entered the Guadalupe Mountains in search of the Apache, and may have passed through lands now within the park. American military expeditions against the Mescalero Apache occurred during the mid to late 1800s.

Texas cattle drovers established trails, such as the Loving, Goodnight, and Slaughter cattle trails during the 1860s. Many open- range cattle camps are found across the area. Homesteading began in the 1880s and the Henry H. Harrison and Washington Ranch at Rattlesnake Springs are good examples of Homestead Era settlements. Numerous remains of other homesteads and water control features are found throughout the park. The Lowe Ranch has significant interpretive value; other ranch sites consist mostly of remnants of stone foundations, trash deposits, and small amounts of fencing materials. Surface remnants of past guano mining activity consist of a few rock foundations and scattered metallic debris.

There are some 200 archeological sites recorded for the approximately 4,000 acres (roughly 10 percent) of the park surveyed to date, and many more are believed to exist. Ring middens make up perhaps two- thirds of the sites within the park. Ring middens (also known as midden circles, sotol pits, or mescal pits) are doughnut- shaped structures of burned rock, ash, and occupational debris. There is considerable variation in these sites; however, it is generally assumed that their major use was in roasting and preparing mescal plants (agave) or sotol bulbs for food. The rest of the known sites consist of rock shelters, cave sites, pictographs, mortar holes, and lithic scatters presumably marking campsites. All sites are protected under the Archeological Resource Protection Act (1979). Two sites, Upper Painted Grotto and Lower Painted Grotto, contain polychromatic pictographs.

Most development at Carlsbad Caverns National Park since 1926 has been focused on tourism. In the late 1920s and early 1930s, the park built sturdy limestone structures in the Pueblo architectural style on the north slope of Bat Cave Draw. A building contractor added a finely crafted limestone building to serve as the superintendent's quarters and an elevator shaft house in the mid 1930s. The Civilian Conservation Corps, or CCC, constructed solid adobe residences and other structures in the late 1930s and early 1940s. Other buildings were added or remodeled during the 1960s. The List of Classified Structures (LCS) records 30 classified structures in the park.

All of the historic structures are either listed or considered eligible for listing in the National Register of Historic Places. Few archeological sites have been individually nominated for listing in the National Register, but areas with site concentrations have been listed or determined eligible for listing. Lower Painted Grotto is also on the National Register of Historic Places (Upper Painted Grotto is not).

The Caverns Historic District and the Rattlesnake Springs Historic District are both listed on the National Register. Elements of the historic districts also make them eligible for designation as cultural landscapes. Cultural landscape features associated with these districts were inventoried in 1993 (CCNP 1996, NPS 1999/20004, NPS 1999/2003). A cultural landscape may be described as an expression of human adaptation to and use of the natural resources of an area. All cultural landscapes evolved from, and depend on, natural resources—interconnected systems of land, water, native vegetation and wildlife. Additionally, an ethnographic overview and assessment (Greenberg 1996), and an ethnographic literature review and assessment (Hendricks and Thomas 2004) of Carlsbad Caverns National Park have been completed.

The Caverns Historic District encompasses 13 rustic stone and adobe structures that are used as maintenance, residential, utility, cave research, and administrative facilities. The earliest buildings (done in Pueblo Revival style) and the terracing are built of local bedrock limestone; later construction was of adobe, in the New Mexico Territorial Revival style. Both the historic district and the area along Bat Cave Draw are managed as a cultural landscape. The buildings and landscape features represent the rustic theme for facility development used during the early years of NPS construction in parks. Landscaping with Chihuahuan Desert vegetation also strengthens the tie to the setting (CCNP 1996, NPS 1999/2004). The Caverns Historic District and the cultural landscape of the Carlsbad Cavern entrance area are managed for the 1926- 1942 period of significance (NPS 1999/2004).

The Rattlesnake Springs Historic District is managed as a cultural landscape as well, due to the combination of significant natural and cultural features identified in the 1993 survey. Some of the significant characteristics include irrigated fields, fruit and ornamental trees, and two CCC- era structures (NPS 1999/2003). The adobe ranch house and pumphouse are representative of Territorial Revival and Pueblo Revival architecture, respectively. The irrigation system—with its gravity flow, concrete- lined ditches, pond, and sluice gates—is the most significant feature of the cultural landscape.

Impact Topic 5 (Changes in Landscape- Scale Vegetation Patterns)

Due to its location in the northern Chihuahuan Desert, Carlsbad Caverns National Park is biotically and physiognomically diverse. The diversity reflects many factors, including latitude, elevation, topography, soil composition, precipitation, climate and fire. Five dominant structural types occur within the park and are described briefly here and shown in Figure III- 3 (page 46). The following descriptions of vegetation communities are from the park's 2003 vegetation map and narrative (Muldavin et al. 2003).

Desert Shrublands

Desert shrublands encompass a large area of the park at the lower elevations, particularly at the southern and eastern portions of the park. These shrublands in the park contain a large and diverse group of Chihuahuan Desert scrub communities. Common species include sotol, creosotebush, redberry juniper, whitethorn acacia, prickly pear, tarbush, lechuguilla, ocotillo, catclaw mimosa, muhly grasses, grama grasses, and slim tridens.

Expert opinion varies on historical fire frequencies or what the extent and severity of historic fires in shrublands might have been (Gebow and Halvorson 2001). There are not reliable historical records of fire frequencies for desert shrublands because there are no trees to carry fire scars from which to estimate fire frequency. Humans have changed the dynamics in shrublands throughout the Southwest. In formerly grassier areas, shrub species are now favored because of grazing and fire suppression.

Plants vary in their responses to fire. Many of the species in this vegetation type can survive and resprout after fire (e.g., acacia and sumac) and creosotebush tolerates low- intensity fire. Succulents fare poorly. Post- fire communities may experience changes in species composition, particularly with an increase in grasses, at the expense of succulents (Kittams 1972, Wright 1990, Paysen et al. 2000).

Desert Grasslands

Much of the remainder of the park is grassland/shrub vegetation, in both cold temperate Madrean Plains- Mesa- Foothill grasslands at higher elevations and warm temperate Chihuahuan semidesert grasslands. The vegetation map designates eight different types of grassland within the park—three types dominated by large bunchgrasses (genus *Muhlenbergia*), four with grama grasses (small

bunchgrasses, genus *Bouteloua*), and tobosa grasslands. . Other common species include dalea, Texas sacahuista, sotol, sandpaper oak, shaggy mountain mahogany, and lechuguilla.

Several of the grassland plant associations in the park are unique in being dominated by curlyleaf muhly. These grasslands "are part of what sets the landscape of CCNP apart from most others in the Southwest," according to Muldavin et al. (2003). They report that curlyleaf muhly occurs almost entirely in the Chihuahuan Desert on rocky limestone slopes (not the traditional image of flat, sweeping grasslands). Little is known about the ecology of curlyleaf muhly, and its response to fire has not been documented. Muldavin et al. (2003) speculate that fire probably reduces this grass in the short term but it may recover in 10 years.

The role of fire in more traditional grasslands has been more widely studied. In the west in general, grassland vegetation has shifted dramatically from historic times as the minor shrub component has become more dominant. Many ecologists consider the change in vegetation composition and structure to be the result of reduced frequency of fires, grazing, and possibly climate changes. In general, fire is understood to reduce shrub cover and maintain a grassland aspect (Kittams 1972). Fires in these grasslands often occur during a drought year after one or more seasons of above- average rainfall that produces abundant fuel (Wright 1990). Fire may stimulate or damage grama grasses depending on climatic conditions, season, and fire severity (Paysen et al. 2000). From the Chihuahuan Desert fire literature, it can be concluded that grasslands in the region recover from fire within 5 to 10 years (Gebow and Halvorson 2001).

Montane Woodlands and Chaparral

The park's dominant vegetation in the mid- and upper elevations is montane shrublands (3,800 to 6,300 feet). Common species in the four plant alliances within this group include Texas sacahuista, sotol, wavyleaf oak, sandpaper oak, redberry juniper, lechuguilla, desert ceanothus, mountain mahogany, and numerous grasses. Fire plays an important part in the establishment and continued maintenance of montane shrublands. The oaks, mountain mahogany, and redberry juniper can recover well from fire and are important in these fire- adapted ecosystems (Muldavin et al. 2003). According to Wright (1990), fire regimes for interior chaparral shrublands in the Southwest generally are characterized by stand- replacing events spaced decades apart. Muldavin et al. (2003) suggest that vegetation patterns in CCNP lead to the conclusion that factors other than past suppression affect shrubland distribution, such as climate, weather, landscape, and increased human ignitions.

Woodland and Forest

Woodland and forest communities occur in the highest elevations of the park. Various plant associations are represented in these communities, some of which are related closely to the Sierra Madre of northern Mexico or to the southern Rocky Mountains. Most of these associations are woodlands; the forests are represented by small ridgetop patches. Major tree species in these communities include various oaks, piñon and ponderosa pines, and alligator juniper. These forests and woodlands have a relatively open structure, with an understory similar to grassland/shrub communities. Muldavin et al. (2003) note that past fire management in the park (suppression and fuel buildup, followed by large crowning fires) have probably contributed to a decline in woodland acreage, and that the extent of the woodlands before the 20th century was probably much larger. Historical fire frequencies of 5- 10 years are known for ponderosa pine stands elsewhere in the Southwest, including the higher country of the Guadalupe Mountains (Ahlstrand 1981).

Thick- barked adult ponderosa pine trees tolerate fire. Alligator and redberry juniper are topkilled by fire, but they resprout from basal roots. Fires approximately every 10 to 30 years tend to decrease

juniper densities. Oak species are known to resprout following topkill by fire. After these woodlands burn, grasses and forbs move in and eventually become the fine fuels that will carry the next fire. A bigtooth maple- oak- Texas madrone woodland occupies canyon bottoms. This woodland type is less fire- prone due to its moister habitat and historically likely burned infrequently.

Arroyo Riparian Woodlands and Shrublands

Desert drainages contain an interesting mix of species—bigtooth maple, oaks, and little walnut in wetter areas, and acacia, catclaw mimosa, and sotol in drier areas, with desert willow, mescal bean, and Apache plume in between. Bunchgrasses also live in these zones. Fire would be expected infrequently in these arroyo settings—fires started on adjacent sparsely vegetated slopes would rarely carry downhill into canyon bottoms. Many of this type's characteristic species have the ability to survive and resprout after fire.

Impact Topic 6 (Wildlife Habitat Change)

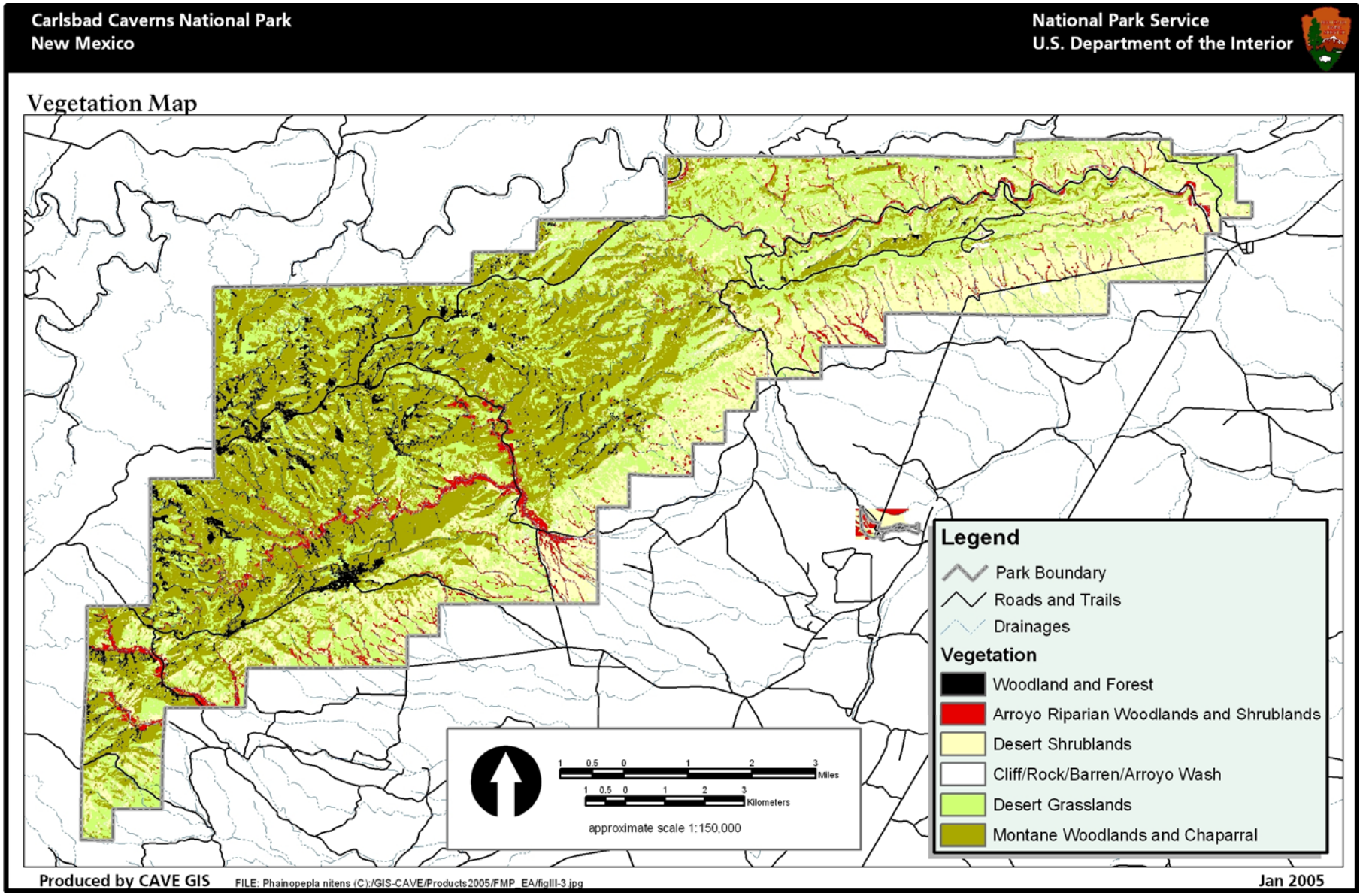
As part of the northern Chihuahuan Desert vegetation zone, the park's vegetation consists mostly of shrubland and grassland, with approximately 750 plant species. Tied to possible landscape- level changes in vegetation are the effects of such changes on wildlife. Rare wildlife species at the park (due to habitat reduction) are most vulnerable to fire- related changes; those especially at risk are species whose habitat has been reduced over their entire range.

Sixty- six species of mammals are recorded for the park, including mule deer, porcupine, ringtail, raccoon, badger, javelina, weasel, and various species of squirrels, rabbits, skunks, mice, and bats (bats are discussed under Impact Topic 7). Carlsbad Caverns has lost some native mammals, including the extinct Merriam's elk and extirpated desert bighorn sheep. Although there are no confirmed park records, prairie dog, gray wolf, and other species may have been historically present. Predators native to the area include coyote, mountain lion, and gray fox.

The park has also recorded over 350 species of birds either accidental in the park, resident, or in migration. Many birds seen in the park are at the limits of their geographic distribution, including the northernmost breeding colony of cave swallows. Birds of particular special interest include obligate riparian species Bell's vireo and yellow- billed cuckoo (see Impact Topic 7). A two- year herpetological inventory documented 40 species of amphibians and reptiles at Carlsbad Caverns in 2003 (Prival et al. 2003) and an additional six species in 2004 (report in preparation). The inventory team estimated that 50 species are likely to occur within the park boundary. The state- endangered species (gray- banded kingsnake) and two state- threatened species were found (mottled rock rattlesnake and Rio Grande cooter, a turtle). Native amphibian species have experienced general declines throughout the Southwest due to loss of habitat, impacts of non- native bullfrogs on local populations, and the susceptibility of amphibians to wildlife diseases and environmental contaminants. However, Rattlesnake Springs supports an apparently healthy population of Rio Grande leopard frogs, despite the presence of bullfrogs.

Riparian and wetlands habitats are particularly important in this arid region. Water is scarce within the park, and there are no permanent surface streams other than at Rattlesnake Springs. In the early 1960s water flow in the park's backcountry seeps and springs was monitored annually. In 1993, 47 seeps and springs were inventoried in the park, approximately 20 of which are permanent water sources and critical to wildlife. Approximately nine acres of the park are mapped by the National Wetlands Inventory as palustrine, temporarily flooded wetlands, including eight acres at Rattlesnake Springs and one acre at Oak Springs. The rarity of riparian areas further magnifies the importance of Rattlesnake Springs for the preservation of regional biological diversity.

Figure III- 3. Vegetation Map



Rattlesnake Springs was acquired by the NPS in 1934 for the primary purpose of ensuring a reliable domestic water supply for cavern area development. Surface flow from Rattlesnake Springs supports 1,000 meters (3,281 feet) of stream course with riparian woodlands and marsh ecosystems. Although the spring is in the park, the stream is almost entirely on land owned by The Nature Conservancy. Rattlesnake Springs provides crucial habitat for an extraordinary number and variety of birds, amphibians, reptiles, mammals, and butterflies.

Slaughter Canyon is a large arroyo riparian site within the park. Dominant species include muhly grasses, slim tridens, and hairy grama; other species are skeletonleaf goldeneye, sotol, mariola, Mormon tea, dalea, lechuguilla, cloak fern, threeawn, hairy tridens, and side- oats grama. Mule deer, javelina, and scaled quail are prevalent in the canyon. Slaughter Canyon provides suitable breeding habitat for the varied bunting and gray vireo. Both birds are listed as threatened by the State of New Mexico. Slaughter Canyon Cave, just within the mouth of the canyon on the west side, is one of the longer caves (1.75 miles long) in the park.

Impact Topic 7 (Special- Status Species)

The isolation of the Guadalupe Mountains, combined with physiographic features such as ridgelines, cliffs, canyons and bajadas, provides habitat for a number of rare species. The following list contains species that are either known to occur in the park or could occur there and are designated as federally threatened or endangered or have special status at the state level.

Special- Status Plants

Natural resources staff at Carlsbad Caverns put together the following list of plant species. Information for this section is largely taken from the New Mexico Native Plants Protection Advisory Committee (NMNPPAC 1984), the New Mexico Rare Plant Technical Council (NMRPTC 1999), and park records.

Lee pincushion cactus (Cactaceae)

Regulatory Status: USFWS threatened species; New Mexico endangered species

Lee pincushion cactus is found almost entirely in Carlsbad Caverns National Park. It is restricted to limestone in areas of broken terrain and steep slopes in desert shrub vegetation, between 1,200 to 1,500 meters (4,000 to 5,000 feet) in elevation (USFWS 1986). The distribution of this plant in the park was documented in a 1984 NPS survey, which mapped the known population of plants and identified the preferred habitat. A new population of this plant was identified in the park in 1994. This variety is common within its very restricted area of distribution. It is popular with collectors and has been subject to commercial collecting (NMNPPAC 1984, NMRPTC 1999), but is now propagated commercially on a large scale and is readily available (NMRPTC 1999). A BA has been prepared, in accordance with Section 7 of the Endangered Species Act.

Sneed pincushion cactus (Cactaceae)

Regulatory Status: USFWS endangered species; New Mexico endangered species

A cactus population morphologically indistinguishable from Sneed pincushion occurs in the park in the same general area and habitat types as Lee pincushion (Baker and Johnson 2000). Closely related to Lee pincushion cactus, Sneed pincushion cactus is known to occur in two separate populations in the Franklin Mountains of El Paso County, Texas, and Doña Ana County, New Mexico (NMRPTC 1999). The unidentified plants in the park have been variously assigned to Sneed pincushion and Lee pincushion and as intermediates between Lee pincushion and another similar species, Guadalupe pincushion (Baker and Johnson 2000). A BA has been prepared, in accordance with Section 7 of the

Endangered Species Act. There is not complete agreement as to whether these populations are in fact Sneed pincushion. Therefore, for this assessment, Sneed pincushion is considered to occur in the park, though some particulars of this taxon are unknown at this time. It is grouped with the Lee pincushion assessment since the varieties may be similarly affected by fire.

Cardinal penstemon (Scrophulariaceae, snapdragon family)

Regulatory Status: New Mexico sensitive species

Cardinal penstemon grows among broken rock and boulders in rocky limestone canyon bottoms and steep slopes (NMNPPAC 1984). This subspecies is associated with montane scrub, piñon- juniper woodlands, and lower montane coniferous forest (NMRPTC 1999). Even though the plant is restricted in range, it is locally abundant and occurs in several remote canyons of the Guadalupe Mountains of New Mexico and Texas (NMNPPAC 1984, NMRPTC 1999). This subspecies was documented in the park by Gelbach (1967).

Chaplin's golden columbine (Ranunculaceae, buttercup family)

Regulatory Status: New Mexico sensitive species

Chaplin's golden columbine occurs in montane scrub or riparian canyon bottoms in Eddy and Otero counties, New Mexico, and in adjacent Culberson and Presidio counties in Texas (TOES 1993, NMRPTC 1999). The plant is found "along perennially moist to wet limestone canyon walls, moist leaf litter, and humus among boulders in wooded mountain canyons" (TOES 1993). Since this species is mostly found in remote canyons, "it is well protected from most human impacts" (NMRPTC 1999). Water development is considered the biggest threat to this plant (NMNPPAC 1984, NMRPTC 1999). This variety was first documented in the park by Gelbach (1969).

Five- flowered rockdaisy (Asteraceae, sunflower family)

Regulatory Status: New Mexico sensitive species

Five- flowered rockdaisy grows in remote canyons in crevices high along limestone cliffs. It is found in the Guadalupe Mountains of Eddy County, New Mexico, and adjacent Texas. This species has not been studied extensively, but is considered sensitive by the state of New Mexico due to its relative rarity and its restricted habitat (NMNPPAC1984, NMRPTC 1999). This species is listed for the park by Gelbach (1967).

Gray sibara (Brassicaceae, mustard family)

Regulatory Status: New Mexico sensitive species

In New Mexico, gray sibara is distributed through Otero, Chavez and Eddy counties and into adjacent Texas. The plant is considered very rare except during unusually wet years (Sivinski and Lightfoot 1995). In the Guadalupe Mountains of New Mexico and Texas, this small annual is found growing in crevices and at the base of limestone cliffs (NMNPPAC1984, NMRPTC 1999) in chaparral and piñon-juniper woodland communities. The species has not been documented at Carlsbad Caverns.

Great sage (Lamiaceae, mint family*)*

Regulatory Status: New Mexico sensitive species

Mountain sage occurs in scattered populations in six mountain ranges in New Mexico, Texas, and Chihuahua, Mexico (Walker and Elisens 2001). In the Guadalupe Mountains, the plant is found growing from crevices and rock ledges in north facing and partly shaded limestone cliffs and on canyon bottoms along watercourses (NMNPPAC1984, Walker and Elisens 2001). First described from Carlsbad Caverns National Park, this species is not considered at particular risk due to remoteness of its habitat (NMRPTC 1999).

Guadalupe mescal bean (Fabaceae, pea family)

Regulatory Status: New Mexico sensitive species

Guadalupe mescal bean is a rare endemic to the Guadalupe- Brokeoff mountain ranges of Eddy and Otero counties, New Mexico, and adjacent Texas. The plant prefers to grow on outcrops of pink, limy, fine- grained sandstone that is 1- 2 percent gypsum, in Chihuahuan desert scrub and juniper savanna (NMRPTC 1999).

Guadalupe milkwort (Polygalaceae, milkwort family)

Regulatory Status: New Mexico sensitive species

Guadalupe milkwort is found in the Guadalupe Mountains of New Mexico and Texas and in the Sierra Diablo of Texas (NMRPTC 1999). This delicate perennial is found growing along limestone cliffs and crevices at moderate elevations, in association with montane scrub to lower montane coniferous forest (NMNPPAC1984, NMRPTC 1999). The variety is considered rare throughout its range, owing perhaps to the rarity of its habitat (NMRPTC 1999). The species is listed for the park.

Guadalupe pincushion cactus (Cactaceae, cactus family)

Regulatory Status: New Mexico sensitive species

Guadalupe pincushion cactus occurs in the Guadalupe Mountains of Eddy County, New Mexico, and Culberson and Hudspeth counties, Texas. The plant prefers cracks in limestone and rocky soils of broken mountainous terrain in open oak- piñon- juniper woodland, but may also be found in desert scrub and in lower- elevation coniferous forest (NMRPTC 1999). This species is common in its area of distribution (NMRPTC 1999) and is unconfirmed for the park.

Guadalupe rabbitbrush (Asteraceae)

Regulatory Status: USFWS species of concern; New Mexico sensitive species

Guadalupe rabbitbrush is found in crevices on faces of limestone cliffs and boulders in canyons of the Guadalupe Mountains, less frequently in open gravel alluvium of canyon streambeds (TOES 1993, NMRPTC 1999). It is associated with piñon- juniper woodland and Chihuahuan Desert scrub vegetation communities (NMRPTC 1999). The plant has not been documented at Carlsbad Caverns, but has the potential to occur due to the prevalence of its required habitat in the park. This subspecies is not considered susceptible to human impacts due to its remote rocky habitat (NMRPTC 1999). Guadalupe rabbitbrush also occurs in the Brokeoff Mountains west of the Guadalupes.

Guadalupe valerian (Valerianaceae, valerian family)

Regulatory Status: New Mexico sensitive species

Guadalupe valerian inhabits narrow canyons within the Guadalupe, Sacramento, and Capitan ranges of New Mexico and Texas. It prefers shaded, moist limestone or igneous cliffs, occasionally in canyon bottoms and boulders in creeks, within piñon- juniper woodland and montane coniferous forest (NMRPTC 1999). The plant is considered abundant within its limited range (Sivinski and Lightfoot 1995).

Mat leastdaisy (Asteraceae)

Regulatory Status: USFWS species of concern; New Mexico sensitive species

Mat leastdaisy is found on dry limestone cliffs and ledges at about 1,525 meters (5,000 feet) in the Guadalupe Mountains (NMNPPAC 1984, Sivinski and Lightfoot 1995, NMRPTC 1999). The plant is associated with piñon- oak- juniper woodlands and coniferous forest (TOES 1993, NMRPTC 1999). The plant is listed for the park and is considered locally abundant (NMRPTC 1999).

McKittrick pennyroyal (Lamiaceae)

Regulatory Status: New Mexico sensitive species

McKittrick pennyroyal is endemic to the Guadalupe Mountains (NMNPPAC 1984, USFWS 1985). The species is found in sheltered, moist locations, such as limestone crevices in canyon walls, and among rocks along watercourses and ridges (NMNPPAC 1984, NMRPTC 1999). This species was formerly federally listed as threatened; it was de- listed in 1993 after discovery of inaccessible populations elsewhere in the Guadalupes (USFWS 1993). The species is undocumented for Carlsbad Caverns.

Scheer pincushion cactus (Cactaceae)

Regulatory Status: New Mexico endangered species

Scheer pincushion cactus occurs in open desert grassland and desert scrub communities and prefers gravelly or silty alluvial soils and rocky benches on limestone or gypsum (NMNPPAC 1984, NMRPTC 1999). The variety is little studied, but appears limited to the Pecos River drainage in western Texas and southeastern New Mexico; presence in adjacent Coahuila, Mexico, is unknown (NMRPTC 1999). Populations appear widely distributed at low densities within its range (NMRPTC 1999). One variety of this species is listed for Carlsbad Caverns.

Shining coralroot (Orchidaceae, orchid family)

Regulatory Status: USFWS species of concern; New Mexico endangered species

Shining coralroot is known from Coahuila, Mexico, up through Texas and New Mexico where it is found exclusively in the Guadalupe Mountains (Coleman 2002). The plant inhabits the mountain canyons along the escarpment in the heavy leaf litter and partial shade afforded by oak groves and junipers (NMRPTC 1999, Coleman 2002). The plant is extremely rare throughout its range and is known in New Mexico from a single observation at Carlsbad Caverns in 1977. Another site is known for Guadalupe Mountains National Park. Its extreme rarity makes it vulnerable to collection (Sivinski and Lightfoot 1995, Coleman 2002).

Sparseflower jewelflower (Brassicaceae*)*

Regulatory Status: USFWS species of concern; New Mexico sensitive species

Little is known of the distribution and habitat requirements of sparseflower jewelflower. It is considered endemic to montane shrublands in limestone canyon bottoms of the Guadalupe Mountains of New Mexico and Texas. It occurs in the park and is locally abundant within this range (NMRPTC 1999).

Tharp's blue- star (Apocynaceae, dogbane family)

Regulatory Status: USFWS species of concern; New Mexico endangered species

Tharp's blue- star is found in Eddy County, New Mexico, and Pecos County, Texas (NMRPTC 1999), in open areas in shortgrass grasslands or shrublands in shallow limestone or gypsum soils (TOES 1993, Sivinski and Lightfoot 1995). It is currently known from three populations in the states of New Mexico and Texas (Sivinski and Lightfoot 1995, NMRPTC 1999). The plant has not been documented for Carlsbad Caverns.

Wright's justicia (Acanthaceae, acanthus family)

Regulatory Status: USFWS species of concern; New Mexico sensitive species

Wright's justicia habitat is dry gravelly clay soils over limestone on flats and low hills in desert shrubland or grassland (Daniel 1980, NMRPTC 1999). The species is reported to occur along the western edge of the Edwards Plateau in Texas and in Chihuahuan Desert grassland in Eddy County, New Mexico. Its presence has not been confirmed in the park. Additional information is needed on this species' abundance (Sivinski and Lightfoot 1995, NMRPTC 1999).

Yellowseed nama (Hydrophyllaceae, waterleaf family)

Regulatory Status: New Mexico probable listing

Yellowseed nama is a member of the crevice and rockface plant community in the Guadalupe and Franklin mountains, New Mexico and Texas. It is found growing from partly shaded limestone cliffs and outcrops in montane scrub to piñon- juniper- oak woodland (NMNPPAC 1984, NMRPTC 1999). No threats to this species have been identified (NMNPPAC 1984, NMRPTC 1999). It is suggested that the remote locations and cliff habitats of Yellowseed nama offer considerable protection from human impacts (NMRPTC 1999). This species was documented in the park by Gelbach (1967).

Special- Status Wildlife

Natural resources staff at Carlsbad Caverns put together the following list of wildlife species. Information for this section is largely taken from the New Mexico Game and Fish Department's *Threatened and Endangered Species of New Mexico* (NMDGF 2000). David Roemer's write- up of the park's inventory and monitoring issues (2001) also provided background on these species.

Mexican spotted owl

Regulatory Status: Federal threatened, New Mexico sensitive, USFS sensitive

The Mexican spotted owl is distributed from southern Mexico northward into southern Utah and central Colorado (USFWS 1995). Populations of Mexican spotted owl are disjunct throughout its range, corresponding to the availability of suitable habitat. The owls occupy a variety of habitat types ranging from dense mixed conifer forests to steep- walled rocky canyons. In the Guadalupe Mountains, they typically occur in mixed- conifer, ponderosa pine forest, and piñon- juniper woodland (USFWS 1995). Nest sites are generally located in closed- canopy forests or steep- walled canyons. Listed as an occasional visitor on the park's bird checklist for winter and spring, the Mexican spotted owl is rarely sighted at Carlsbad Caverns. A BA has been prepared, in accordance with Section 7 of the Endangered Species Act.

Southwestern willow flycatcher

Regulatory Status: Federal and New Mexico endangered, USFS sensitive

The southwestern willow flycatcher may reach the eastern edge of its range near Carlsbad Caverns. It prefers thick streamside vegetation, and its rarity is a consequence of the loss of such habitat in the Southwest. In addition to habitat destruction by humans, brown- headed cowbird parasitism, predation, and negative effects of recreation and research activities are all cited as threats. At Carlsbad Caverns, a 1995 survey listed the bird as a migrant at Rattlesnake Springs. It was not included in the BA analysis.

Arid land ribbon snake

Regulatory Status: New Mexico threatened

The arid land ribbon snake occurs in isolated disjunct populations mostly east of the Pecos River and is not confirmed at park. Little is known about its biology. Threats are changes in water use and possibly collecting.

Baird's sparrow

Regulatory Status: Federal species of concern, New Mexico threatened, USFS sensitive

Baird's sparrow is found in the short and mixed grass upland prairies. The bird nests in the northern plains of the US. It winters primarily in northern Mexico, although some may be found in southern Texas, New Mexico, and Arizona. Baird's sparrow has suffered population declines due to habitat loss

mainly from the conversion of native prairie and grasslands to agriculture. USFWS elected not to list the species in 1999 (USFWS 1999).

Bell's vireo

Regulatory Status: New Mexico threatened, USFS sensitive

Bell's vireo prefers dense, low, shrubby vegetation in riparian areas. It summers in southern New Mexico. Declines throughout the range of this species are attributed mainly to loss or fragmentation of dense shrubby and woody riparian habitat. At Rattlesnake Springs, nest parasitism by brown-headed cowbirds decreases its nesting success.

Blotched water snake

Regulatory Status: New Mexico endangered, USFS sensitive

The blotched water snake found in southeast New Mexico is the westernmost subspecies of *Nerodia erythrogaster*. Very few individuals have been located in recent years along the lower Pecos River drainage that includes the Black and Delaware rivers. It requires permanent water, where it forages for fish and frogs. Primary threats are habitat alteration and killing by anglers who mistake it for a venomous snake or believe it depletes game fish populations. In the park, it is found at Rattlesnake Springs.

Gray vireo

Regulatory Status: New Mexico threatened, USFS sensitive

The gray vireo has been little studied, and recent surveys in New Mexico have turned up unexpected numbers. Populations persist in the Guadalupe Mountains. It is most often found in arid juniper woodlands on foothills and mesas, sometimes associated with oaks and piñon pines. Habitat usually has a well- developed grass component. Threats include loss of quality juniper- grassland habitat, and brown- headed cowbird parasitism.

Gray- banded kingsnake

Regulatory Status: New Mexico endangered

The gray- banded kingsnake is a secretive nocturnal inhabitant of the Chihuahuan Desert, occupying dry rocky limestone hills and mountain slopes vegetated with succulents and shrubs. In New Mexico it is known only from Eddy County. It also occurs in central and Trans- Pecos Texas west to the Hueco Mountains and in Mexico. Collecting is the primary threat to this species.

Greenthroat darter

Regulatory Status: New Mexico threatened

Greenthroat darter occurs in two disjunct areas, the Edwards Plateau of south- central Texas and the lower Pecos drainage of New Mexico. The species historically occurred in mainstream and tributary habitats in the Pecos River valley from Bitter Lake National Wildlife Refuge north of Roswell, New Mexico, downstream to the state line. The darter is still relatively common in Texas, but in New Mexico persists primarily in four disjunct areas, one of which is Rattlesnake Springs. Habitat is small streams and springs with clear water, dense aquatic vegetation, and clean gravel and cobble substrates.

Mottled rock rattlesnake

Regulatory Status: New Mexico threatened

The Guadalupe Mountains are at the northern edge of the range of the mottled rock rattlesnake and the only place it occurs in New Mexico. It is rarely found away from rocky canyons or hillsides. Most of its New Mexico habitat is in the park where it is secure except for possible illegal collecting.

Peregrine falcon

Regulatory Status: New Mexico threatened, USFS sensitive

USFWS de- listed the peregrine falcon in 1999, but the New Mexico Department of Game and Fish opposed the move. The agency has seen an increase in occupancy of breeding sites over time, but argues that population numbers are not yet self- sustaining. Peregrines nest in scrapes and depressions dug in gravel on cliff ledges and feed primarily on other birds. Pesticide amplification in the food chain, falconry taking, and disturbance of nest sites continue to be the primary threats to the species.

Rio Grande cooter

Regulatory Status: New Mexico threatened, USFS sensitive

In New Mexico, the Rio Grande cooter is found in the Pecos River drainage below Brantley Dam in Eddy County. It prefers river systems with deep pools and avoids shallow riffles, and is generally abundant locally. Recreational shooting and fishing are the biggest threats to the turtle in the area. Little else is known about the species. In the park, it is known from Rattlesnake Springs.

Varied bunting

Regulatory Status: New Mexico threatened, USFS sensitive

The varied bunting is primarily a Mexican species that summers in southern New Mexico where it prefers dense shrubby vegetation associated with relatively arid canyons. In the park, some canyons provide breeding habitat. Loss of shrubby riparian habitat and brown- headed cowbird parasitism are listed as threats in New Mexico.

Other Species Considered

Bats are among Carlsbad Caverns' principal visitor attractions. With numerous caves, cliffs, trees, and outcrops throughout the park providing ample roosts, bats are among the more common animals in the park. Researchers have documented (live- captured) 16 species of bats in the park since the 1970s. They are the big free- tailed bat, Mexican free- tailed bat, pocketed free- tailed bat, big brown bat, California myotis, cave myotis, fringed myotis, hoary bat, long- legged myotis, pallid bat, eastern red bat, silverhaired bat, small- footed myotis, western big- eared bat, western pipistrelle, and eastern pipistrelle. Seven of these are listed as sensitive by the State of New Mexico (NMDGF 2002). They are: eastern red bat, small- footed myotis, fringed myotis, cave myotis, long- legged myotis, western big-eared bat, and big free- tailed bat.

Of particular interest are the Mexican free- tailed bats. Almost every evening, from early March to late October, these bats stream from the natural entrance to feed on night- flying insects in the nearby Pecos and Black River valleys. The bat flight draws thousands of visitors each year. Rattlesnake Springs has high bat diversity.

Also of unique interest to park visitors is the colony of cave swallows that nest during the summer months just inside the entrance to Carlsbad Cavern and other caves. The Carlsbad Cavern colony is the northernmost in North America. Cave swallows usually arrive at Carlsbad Cavern in the early spring, and depart for winter grounds by late fall.

Impact Topic 8 (Exotic Species)

Appendix F lists over 50 exotic plants known to occur or having the potential to occur at Carlsbad Caverns National Park. These imports from elsewhere can have species- , community- , or ecosystem-level effects by (1) significantly altering natural processes, such as fire regimes, nutrient cycling, hydrology, or *successional* patterns; (2) by altering species composition and reducing populations of native species; (3) through hybridization with native species; or (4) by crowding out native species that

provide superior wildlife habitat and food sources. Some species are disruptive if they affect localized resources, such as archeological features or scenic qualities on a broad scale.

Most non- indigenous plant species enter the park from nearby infested areas by vegetative growth, by windblown seed, or by being carried by birds, mammals, or people (and their vehicles). Non- native bullfrogs were deliberately brought to the west and inhabit streams and springs in the park, hiding under debris at the water's edge. Barbary sheep and feral goats fill the niche formerly occupied by native bighorns. Barbary sheep escaped from a game farm near Hondo, NM, the likely source for the Guadalupe population.

Park staff have identified 16 exotic plant species of particular concern whose biology is reviewed below.

African rue (Zygophyllaceae, caltrop family)

Regulatory status: New Mexico Class B noxious weed

African rue is an Old World perennial that reproduces primarily by seeds, but can produce new shoots from its deep taproot when severed. Seeds fall near parent plants and are spread by water, humans, machinery, and animal feet, fur, and feathers. It does well along dry roadsides and on degraded rangelands and can tolerate saline conditions. African rue is not presently known in the park, but occurs throughout Eddy County along roads and at oil field sites.

Ailanthus (Simaroubaceae, quassia family)

Ailanthus, or tree of heaven, is a rapidly growing deciduous tree that reproduces through seeds or vegetatively. Mature trees can reach 80 feet or more in height. Abundant seeds are produced in late summer to early fall. Ailanthus is a prolific seed producer, grows rapidly, and is considered *allelopathic* (Lawrence et al. 1991). Ailanthus is common in disturbed urban areas, roadsides, and fencerows; in the park, it occurs along a both sides of a fence at Rattlesnake Springs.

Field bindweed (Convolvulaceae, morning glory family)

Regulatory status: New Mexico Class C noxious weed.

A native to Mediterranean Europe, field bindweed reproduces by seed but also by vigorous growth from its deep rhizomes, forming dense colonies in open habitat. It flowers from late April to October throughout its range. Seeds mature within two weeks and are viable for 30 years or more. Rhizome growth is the primary mechanism by which it persists following disturbance. It is found in all developed areas and many old ranch sites in Carlsbad Caverns.

Johnson grass (Poaceae, grass family)

An African native, perennial Johnson grass was planted extensively throughout the region for soil stabilization and range improvement (Anderson 1999). Johnson grass reproduces via seeds and rhizomes. It withstands high levels of desiccation and other adverse conditions. Heat (up to 90° F) increases sprouting. Seeds drop near parents and can be spread by wind and water, ingestion by birds and cattle, as contaminants in grain and hay, and by farm equipment. It prefers depressions, roadsides, riparian areas, and cultivated fields. Johnson grass invades native grasslands after flooding. Its size, fast- growing sprouts, and dense patches help it outcompete natives. It is now a significant component of the vegetation at Rattlesnake Springs.

Klein grass (Poaceae)

Klein grass is a warm- season perennial bunchgrass introduced from Africa. It has been planted extensively in the western US as a forage plant, popular for its production and palatability. It is fine-

stemmed, leafy, and grows to a height of 3 to 4 feet and spreads by seed or short rhizomes. Klein grass is spreading at an old ranch site in Slaughter Canyon.

Lehmann lovegrass (Poaceae)

Lehmann lovegrass has been introduced to the Southwest from South Africa since the 1930s for range restoration purposes. It is a warm- season perennial grass, reproducing by seed. It produces large amounts of seeds in the fall that are dispersed by the wind. Lehmann lovegrass was planted several decades ago around administrative buildings at the park and spread rapidly during the rainy summer of 2004. Occurrence elsewhere in the park is probable but unknown. It has an aggressive spreading habit and displaces native wildlife and plants. Lehmann remains semidormant until peak summer rains (Cable 1971, Cox et al. 1988).

Malta starthistle (Asteraceae)

Regulatory status: New Mexico Class B noxious weed

Malta starthistle is an annual to biennial herbaceous plant, reproducing by seeds. It produces abundant seed crops that are dispersed short distances by wind, vehicle tires, people, and other animals. Germination occurs following fall rains (DiTomaso and Gerlach 2000). Flowering occurs from winter to spring (West 2003, personal communication). It occurs in disturbed areas, such as agricultural fields, along ditches and roadsides throughout Eddy County. In the park, Malta starthistle is found along the entrance road, in developed areas, and at occasionally at Rattlesnake Springs.

Puncturevine (Zygophyllaceae)

Puncturevine (goathead) is a prostrate mat- forming summer annual. It self- pollinates and likes barren areas and hot weather. Seeds in the soil seed bank have long- term viability and sprout with early spring moisture flushes. Seeds are burrs that easily stick to animals, humans, and tires. The plant occurs in developed areas of the park.

Russian olive (Elaeagnaceae, oleaster family)

Regulatory status: New Mexico Class C noxious weed

Russian- olive is an Old World species planted extensively throughout the region in the early 1900s for soil stabilization and as an ornamental. It has a tendency to spread where not desired, and can rapidly colonize and displace native riparian vegetation. Russian- olive is a vegetation component at Rattlesnake Springs.

Russian thistle (Chenopodiaceae, goosefoot family)

Russian thistle or tumbleweed is a warm- season annual and highly effective reproducer. After seeds mature in the late fall, the plant stem separates from the root and is then blown by wind. Seeds are dispersed as the plant tumbles along. Plants tolerate hot, very dry conditions in disturbed areas. Russian thistle inhabits areas around parking lots, along dirt roads, and open sites at Rattlesnake Springs.

Saltcedar (Tamaricaceae, tamarisk family)

Regulatory status: New Mexico Class C noxious weed

Saltcedar or tamarisk was planted for erosion control and windbreaks and began invading riparian areas in the Southwest in the late 1800s. The trees spread via prolific seed production, resprouting and layering. Disturbance is not a prerequisite for colonization. Tamarisk grows on lands surrounding the park and appears from time to time as conditions allow, but is not a major component of park vegetation.

Scotch thistle (Asteraceae)

Regulatory status: New Mexico Class A noxious weed

Scotch thistle is a biennial, in ideal conditions producing a plant up to 8- feet- tall and 5 feet in diameter by its second season. Under poor growing conditions, the plants may stand less than a foot tall, but can produce nearly as many seeds as the larger plants. The plant flowers in the summer, and prefers disturbed areas, such as roadways, campsites, burned areas and ditch banks. Scotch thistle was eradicated from the park in 1999, and is on the watchlist of potential invasives.

White horehound (Lamiaceae)

White horehound is a drought- tolerant perennial from Europe that reproduces by seeds and may be self- fertilizing. Spiny, hooked seeds attach easily to animal fur and human clothing; they are also spread by water and vehicles. Horehound establishes on infertile soils and is often the first colonizer in eroded areas. It is found in disturbed areas throughout the park.

Woolly mullein (Scrophulariaceae)

Woolly or common mullein is an herbaceous biennial that invades open disturbed areas, wetlands, and meadows. Seeds germinate with summer rains and the likelihood of survival to a second year increases with earlier germination. The tiny seeds are viable for decades; they slip below the soil surface and are brought back with disturbance.

Chapter IV: Environmental Consequences

Methodology

The IDT selected impact topics, including the mandatory topics listed in Table II- 3, during the internal scoping process whereby all alternatives were evaluated for their effects to resources and values. For each topic, impacts are defined in terms of context, intensity, duration, and timing. Direct, indirect, and *cumulative effects* are discussed for each impact topic, as well as mitigation measures. The terms *impact* and *effect* are used interchangeably throughout the document, and are broadly defined for the purposes of this analysis as the result or consequence of a particular action on the status or integrity of a given park resource. Definitions of intensity levels varied by impact topic, but the following definitions applied to all topics:

Beneficial: A positive change in the condition or appearance of the resource or a change that moves the resource toward a desired condition.

Adverse: A change that moves the resource away from a desired condition or detracts from its appearance or condition.

Direct: An effect that is caused by an action and occurs in the same place and time.

Indirect: An effect that is caused by an action, but is later in time or farther removed in distance, but is still reasonably foreseeable.

Cumulative Effects

All alternatives were also evaluated for cumulative effects. The CEQ defines cumulative effect as "the effect on the environment that results from the incremental effect of the action(s) when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non- Federal) undertakes such action" (40 CFR § 1508.7). In order to determine cumulative impacts, a cumulative scenario was developed. Besides the normal day- to- day activities of the park, the scenario includes unique or external events that, together with the actions of each alternative, may have a cumulative impact to the resource in question. For Carlsbad Caverns National Park, the scenario includes the following actions:

- Renovation of the visitor center, resurfacing of the visitor center parking lot, and renovation of the Walnut Canyon entrance road beginning in 2006 and extending roughly 18 months
- Replacement of the sewer line from the visitor center to the wastewater treatment site at the base of the escarpment after the above renovations
- Surveys of Barbary sheep in the park involving helicopter overflights 2 to 3 times per year for 3 years
- Past grazing activities
- Illicit collection of sensitive cactus species
- Ongoing education programs at the park
- Wildland and prescribed fires on nearby lands
- Past and future fire management activities at Carlsbad Caverns

Three alternatives were analyzed that apply different combinations of four fire management tools: wildland fire use, suppression, prescribed burning and mechanical thinning. The framers of these alternatives envisioned Alternative 2 to result in the most suppression and highest risk of future conflagrations. The No Action Alternative automatically suppresses in developed or sensitive areas,

allowing wildland fire use in the park's interior and under a narrower range of conditions along the park's boundary that can help reduce the incidence of future large- scale fires. Alternative 1 takes the No Action Alternative one step further, by relaxing the conditions on wildland fire use along the park's boundary, theoretically reducing fuels more effectively and ultimately slowing the movement of future wildland fires into and out of the park.

There is no way to identify exactly how much of each tool would apply if any one of the alternatives were selected, because the amount of each type depends on numerous variables, such as weather, lightning ignitions, the Region 3 preparedness level based on current fire danger and availability of firefighting resources, and the status of cooperative agreements with park neighbors.

In order to conduct this analysis, the IDT made the following assumptions on how much of each fire management tool will most likely occur:

- There will be wildland fire use in increasing amounts and suppression in decreasing amounts from Alternative 2 to Alternative 1, with the No Action Alternative somewhere in between.
- The amount of prescribed fire will be higher for the No Action Alternative and Alternative 1 than for Alternative 2.
- Mechanical thinning will be greatest under Alternative 2 and about the same for the No Action Alternative and Alternative 1.

The analysis that appears in this chapter for each impact topic was generated in preliminary form in a scoping session January 22, 2003, at the park, with full participation by natural resource, cultural resource and fire staff, plus the University of Arizona cooperators.

The analysis also predicts whether alternatives will result in *impairment*. The NPS is required by law to guarantee that resources are passed on to future generations "unimpaired." Impairment is defined as a major, adverse impact to a resource or value whose conservation is (1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of Carlsbad Caverns National Park; (2) key to the natural or cultural integrity of the park; or (3) identified as a goal in the park's GMP or other relevant NPS planning documents. Thus, NPS is prohibited from taking any action that would or would likely impair the integrity of a resource or value essential to the purpose or identity of the park. In this EA, the professional judgment of staff, relevant studies, and public input are the basis for impairment determinations.

Table IV- 1 (page 86) summarizes the impacts of each alternative over the eight impact topics. Appendices to this chapter include the cultural resources matrix (Appendix C) prepared as part of the CRC for evaluation by the New Mexico SHPO, and a summary of fire effects to selected vegetation (Appendix G).

Impact Topic 1 (Life and Property)

The first and foremost objective for fire management is the protection of life, property, and resources from the unacceptable effects of wildland or prescribed fire. Life and property encompasses park staff, firefighters, and visitors, as well as park developments and personal property of everyone concerned.

The alternatives cover a range from few prescribed fires in the short- term and continued risk of high-severity fire to more fire (prescribed and wildland fire use) in the short- term and less risk of high-severity fire overall.

Under all alternatives, fires will be monitored and evaluated for safety as conditions change. If necessary, an area of the park may be closed because of hazardous conditions. In addition, evacuations may be ordered if necessary to ensure public and employee safety. Public notification is a fundamental part of public safety efforts. Emphasis is placed on providing information to visitors, reducing impacts on their visit, and promoting public safety. The park's public information office and incident fire information personnel distribute information through press releases, special notices and other communications as needed to inform other agencies, neighbors, communities, and individuals of fire management activities.

Alternative 1 provides the best protection of life and property in the long- term.

Life and Property Intensity of Effects Defined

Negligible: Life and property would not be affected, or the effects would be barely detectable and would not have an appreciable effect on life and property.

Minor: The effect would be detectable and would likely be short- term, but would not have an appreciable effect on life and property. If mitigation were needed, it would be relatively simple and would likely be successful.

Moderate: The effects would be readily apparent and long- term, and would result in substantial, noticeable effects to life and property on a local scale. Mitigation measures would probably be necessary and would likely be successful.

Major: The effects would be readily apparent and long- term, and would result in substantial, noticeable effects to life and property on a regional scale. Extensive mitigation measures would be needed, and their success would not be guaranteed.

Short- term: Effects last for the duration of the fire management action.

Long- term: Effects continue after the fire management action has been completed.

Assessment Methodology

Assessment of effects of alternatives on life and property is based on park staff experiences to date. Fuel reduction programs have been successful at preventing damage and loss; personnel management practices during fire operations have circumvented injury and loss of life.

No Action Alternative: 1995 FMP

Impact Analysis: The threat of impact to life and property peak in the late spring and persist through high fire seasons. Threats exist during fires and impacts are immediate. Fire location matters—fires of similar size and intensity in different locations pose very different threats to life and property. The No Action Alternative allows out- of- season prescribed fires to minimize risk to property. The *direct effects* (adverse impacts to life and property) remain minor, and are further decreased with mitigation measures outlined below. Long- term threats to safety and property will be reduced as fuel treatment objectives are met. The *indirect effects* (threats to life and property) subside with burning in the Conditional Suppression Zone (FMU 2), reducing the risk of fire crossing into the park from the outside.

Mitigation measures educate the staff and public about fire prevention, particularly in peak fire and high risk seasons; notify the public about pending and on- going activities to reduce potential disruption to visitors; take protective measures to minimize the public's exposure; prepare or update cooperative agreements for fire suppression on private lands to reduce fuel hazards outside the park;

mechanically reduce hazardous fuels; construct fire breaks around sites; conduct prescribed burning using natural barriers to control size; and time prescribed fire during less severe conditions.

Cumulative Effects: Cumulative effects on life and property include concerns within the park and the community of Whites City. Based on the list of related activities appearing at the beginning of this chapter, the cumulative effect analysis finds:

- Ongoing education programs can stress fire safety and have a minor *beneficial effect* on life and property
- Past and future fire management activities at Carlsbad Caverns may have a minor direct adverse effect on life and property, but indirect long- term beneficial effects as fuels are reduced.

Conclusion: Using appropriate mitigation measures, impacts are expected to be minor, adverse and short- term. Short- term, adverse impacts to public safety and property would be minor with appropriate protective measures. Minor, long- term, beneficial impacts to life and property would accrue as hazard fuels are managed.

Alternative 1: Full Toolbox

Impact Analysis: The context and timing of Alternative 1 is similar to the No Action Alternative with the additional possibility of fire crossing the park boundary. This cooperative element expands the context to include more neighboring lands. The intensity and duration of Alternative 1 is similar to the No Action Alternative, though threats to life and property are reduced with increased wildland fire use across boundaries. The direct and indirect effects are also similar to the No Action Alternative. Alternative 1 causes the least direct impact in the long- term because of a decreased threat of high-severity wildland fires as boundary areas burn. In addition, the indirect effects of Alternative 1 minimize the movement of fire into the park from outside over the long- term as more of the boundary burns. Low- to moderate- intensity wildland fire use events with mosaic burning patterns will provide firefighter safety zones. Large- scale prescribed fire will pre- treat possible wildland fire use areas and reduce risks of escaped fires in the future.

The mitigation measures are the same as the No Action Alternative.

Cumulative Effects: The cumulative effects are similar to the No Action Alternative, but cooperative management of adjoining landowners provides a wider region of reduced fuels.

Conclusion: Increased wildland fire use, with appropriate protective measures, would result in short-term, minor adverse impacts to public safety and property. Minor, long- term, beneficial impacts to life and property would accrue as management objectives of fuel reduction are met.

Alternative 2: Limited Prescribed Fire

Impact Analysis: Fuels will accumulate without wildland fire use and the limited prescribed burning of Alternative 2. Limited prescribed fire increases the risk to life and property during periods of severe fire conditions. The intensity and duration of this alternative is similar to the No Action Alternative, though threats will increase as fuel loads increase. With the highest amount of suppression, Alternative 2 could increase exposure of firefighters to dangerous conditions on the ground and to hazardous firefighter equipment and machinery. With the most suppression, this alternative causes a potentially moderate direct, adverse impact to firefighter safety. Indirectly, the suppression focus of this alternative threatens park neighbors as the risk of large wildland fires increases in the long- term with reduction of fuels.

The mitigation measures are the same as the No Action Alternative.

Cumulative Effects: The cumulative effects are less effective than the No Action Alternative and Alternative 1. Fuels build up within and outside the park, which increases risks to human safety and park resources.

Conclusion: This alternative places firefighters at risk more often than the No Action Alternative and Alternative 1. Otherwise, with its maximum suppression, Alternative 2 minimizes short- term, adverse impacts to the public, staff and property; such impacts would be minor or negligible in intensity. In the long- term, there is potential for moderate adverse impacts to firefighter and public safety and to property during periods of severe fire conditions.

Impact Topic 2 (Park Neighbors)

Other federal agencies, private ranches, and the gateway development of Whites City are Carlsbad Caverns National Park's main neighbors. There is a history of fire crossing from the Lincoln National Forest to the park, due to the prevailing winds from the west. Fires have also burned across boundaries with the BLM. Cooperation with these agencies is ongoing; more cooperation is proposed under the preferred alternative. Past prescribed burning has focused on treating areas to keep future fires within the park. Protecting Whites City is a priority under all alternatives.

Because fuels are contiguous between the park and neighboring lands, the potential exists for fires to cross from the park to neighboring lands and vice versa. Alternative 1 minimizes the incidence of fire crossing out of the park in the long- term, and entails the highest level of cross- boundary cooperation and agreement.

Park Neighbors Intensity of Effects Defined

Negligible: The impact on neighbors is at the lowest levels of detection.

Minor: The impact is slight but detectable, and would affect few park neighbors.

Moderate: The impact is readily apparent, and would affect many park neighbors or a considerable portion of one or more neighbor's property.

Major: The impact is widespread or unavoidable and would affect many park neighbors.

Short- term: Effects last for the duration of the fire management action.

Long- term: Effects continue after the fire management action has been completed.

Assessment Methodology

Staff considered past experience with park neighbors during fire events and general knowledge of neighbor expectations to determine impacts.

No Action Alternative: 1995 FMP

Impact Analysis: Under the No Action Alternative, prescribed fire provides more control over when and where fires occur. In addition, the duration and intensity of impacts to neighbors would decrease over time due to a reduction in the fuel load. There could be minor, adverse direct impacts to neighbors in the short- term due to smoke. Forage for grazing animals could be temporarily reduced. Reduction of fuels that allow fire to escape the park will lessen risk over time. The indirect effect is that neighbors may benefit from range improvement and hazard fuel reduction where fire is allowed to cross boundaries.

Mitigation measures inform neighbors of pending burns; reduce fuels mechanically to minimize neighbors' exposure; rehabilitate burned areas following unwanted fire on neighboring property; prepare or update cooperative agreements for fire suppression on private lands; coordinate burns with adjacent and nearby land managers; suppress fire adjacent to neighbors with whom the park has no agreement; formulate prescriptions to exclude severe conditions.

Cumulative Effects: Cumulative effects on park neighbors include concerns within the park, on the lands of private and public neighbors adjacent to the park, and in the community of Whites City. Based on the list of related activities appearing at the beginning of this chapter, the cumulative effect analysis finds:

- Ongoing education programs can stress positive aspects of the fire program and have a minor beneficial effect on park neighbors
- Past and future fire management activities at the park may have a minor short- term adverse effect on park neighbors, but fuels reduction will reduce long- term risk of wildland fire.
- Wildland and prescribed fires on nearby lands may have a minor short- term adverse effect on park neighbors, but fuels reduction will reduce long- term risk of wildland fire.
- Barbary sheep surveys using helicopters will add negligible short- term adverse effects to the effects of a fire operation's helicopter use on neighbors.
- Overall, there may be short- term negative perception of these impacts until the longer- term benefits are understood and realized.

Conclusion: Fire management- related impacts to park neighbors, such as from smoke, would be adverse but short- term and minor. Moderate, long- term, beneficial impacts to park neighbors would occur as fuels are reduced along the park boundary, thus lowering the risk of fire escaping park boundaries. Temporary loss of forage may occur, but fire is likely to ultimately improve restored rangelands.

Alternative 1: Full Toolbox

Impact Analysis: Alternative 1 is similar to the No Action Alternative, though the context expands to include more neighboring areas. The intensity, duration, and effects are also similar to the No Action Alternative. Alternative 1 has the least impact to neighbors in the long- term as the park returns to a natural fire regime, which reduces the likelihood of high- severity fires. The direct effect is that risks of affecting neighbors decrease over time with fuel reduction. Indirectly, moderate benefits accrue to a greater number of neighbors.

The mitigation measures are the same as the No Action Alternative.

Cumulative Effects: The cumulative effects are the same as the No Action Alternative.

Conclusion: Fire management- related impacts to park neighbors would be adverse but short- term and minor, as described under the No Action Alternative. Major, long- term, beneficial impacts to park neighbors would occur with reduction in fuel load at park boundaries over time and renewed landscapes and habitats with increasing wildland fire use. Collaboration with neighboring land management agencies and private landowners allows management actions that best meet the needs of affected parties.

Alternative 2: Limited Prescribed Fire

Impact Analysis: Under Alternative 2, the absence of prescribed burning limits the control of fire timing and location. The intensity and duration would vary with each fire. Mandatory suppression over most of the park should shorten fire duration, causing any impacts to be short- term, but would continue the risk of high- severity fire in the future from buildup of fuels. Suppression and mitigation should minimize direct effects in the short- term. Potential for fire escape increases as lack of fire brings about fuel buildups. An indirect effect increasing the risk of wildland fire crossing into neighboring land increases over time as fuel buildup continues.

The mitigation measures are the same as the No Action Alternative.

Cumulative Effects: The cumulative effects are the same as the No Action Alternative.

Conclusion: Under this alternative, in- park ignitions are to be suppressed within park boundaries. Due to continued fuel buildup along park boundaries, the likelihood of fire crossing out of the park increases in the long- term. The amount of mechanical fuel reduction needed to protect the park boundary would be cost prohibitive. Fire management- related impacts to park neighbors would be adverse, but short- term and minor to moderate.

Impact Topic 3 (Tourism)

The direct, adverse effects to local tourism from prescribed and wildland fire use result from short-term visitor- use restrictions during a fire event. Although such restrictions might divert tourists from the area and cause a short- term decline in revenue for tourism- related businesses, multiple convenient alternate destinations are available. The short- term impacts to Whites City adjacent to the park may be higher than for the larger city of Carlsbad. Whites City could be a less pleasant location when fire is present in and around the park due to possible smoke and helicopter noise. The intensity of effects would vary according to extent, severity, and location of a fire event, and the immediate perceived threat to safety.

There may be long- term effects to park visitation as potential visitors may be disinclined to visit a burned landscape if other options for outdoor recreation are available. However, because Carlsbad Cavern itself is by far the primary attraction of the park, burned vegetation is considered to have a negligible effect on the willingness of visitors to travel to the park. A direct, minor long- term benefit to local tourism may result from a reduction of high- severity fire potential over time.

Prescribed burning and wildland fire use are major components of the No Action Alternative. For Alternative 1, wildland fire use is proposed to play a greater role. Thus, smoke may be present a greater amount of the time. As such, the effects of Alternative 1 to visitor numbers and the local tourist industry may slightly exceed expected effects under the No Action Alternative. Alternative 2 minimizes the short- term impacts to tourism by suppressing all unplanned ignitions. However, the potential for adverse impacts to tourism in the future is highest under Alternative 2 relative to the other two alternatives.

In the park's 74- year history, fire operations have not necessitated road closures. Because the park has a single road for access, there always remains the possibility of some short- term closures in the future when fire is too close for safe travel. Although large or wind- driven fire events might force visitor use restrictions or closure, tourists to the region also have many other destination choices.

The No Action Alternative and Alternative 1 reduce the potential for long- term effects by eliminating fuels likely to maintain high intensity, large- scale fires; Alternative 2 reduces short- term effects on tourism by suppressing the most fires.

Tourism Intensity of Effects Defined

Negligible: Almost no tourists would change their plans.

Minor: A small but detectable number of tourists would change their plans.

Moderate: A noticeable number of tourists would change their plans.

Major: Most tourists would change their plans.

Short- term: Effects last for the duration of the fire management action.

Long- term: Effects continue after the fire management action has been completed.

Assessment Methodology

Park staff's knowledge of the local economy and visitor travel patterns is the basis for the conclusions.

No Action Alternative: 1995 FMP

Impact Analysis: Effects on tourism would be greatest during peak fire season (summer) or during prescribed burns in spring and fall. The intensity and duration of effects would vary directly with the extent and severity of a fire event and the immediate perceived threat to safety imposed by the fire. Reduction in fuel loads should decrease future duration of trail, road, or park closures. Direct adverse temporary effects to local businesses from visitor- use restrictions are possible in the short- term. Fuel- load reduction will decrease the potential for trail, road, or park closures over the long- term. The indirect effect of decreased cave visitation is not expected because of the post- fire landscape.

Mitigation measures time prescribed burns to avoid periods of high visitation; formulate prescriptions to exclude severe fire (and smoke) conditions; coordinate burns with adjacent and nearby land managers to minimize cumulative impacts in the region; publicize alternate destinations; and use fires as interpretive opportunities.

Cumulative Effects: Cumulative effects on tourism include concerns within the park, private and public neighbors adjacent to the park, and the community of Whites City. Based on the list of related activities appearing at the beginning of this chapter, the cumulative effect analysis finds:

- Ongoing education programs can stress fire safety and positive effects of fire and have a minor beneficial effect on tourism.
- Past and future fire management activities at the park may have a minor short- term adverse effect on park neighbors, but fuels reduction will reduce long- term risk of wildland fire.
- Wildland and prescribed fires on nearby lands may have a minor short- term adverse effect on park neighbors, but fuels reduction will reduce long- term risk of wildland fire.
- During severe fire seasons, systematic closures on public lands in the region are possible. Reduction in fuels long- term will reduce the potential for park closure during severe seasons, benefiting park tourism when other recreation areas restrict access.
- Overall, directed fuels management will reduce long- term risks to tourism. Rare weather events and uncharacteristic seasons, which are outside human influence, may interrupt tourism in unknown ways.

Conclusion: Fire program impacts to local tourism- related businesses would be negligible. Minor, long- term, beneficial impacts to local tourism- related businesses would occur with maintenance of biodiversity and reduction in fuel load over time.

Alternative 1: Full Toolbox

Impact Analysis: The context and timing is the same as the No Action Alternative. Duration and context of Alternative 1 is similar to the No Action Alternative. As fire reduces fuels across boundaries, though, there will be a further reduction in duration of possible closures in the future. The direct effects are similar, as well, but an increased use of fire will further reduce long- term potential for impacting tourism. The indirect effects are the same as the No Action Alternative.

Mitigation measures are the same as the No Action Alternative.

Cumulative Effects: Cumulative effects are the same as the No Action Alternative.

Conclusion: Fire program impacts to local tourism- related businesses would be negligible. Minor, long- term, beneficial impacts to local tourism- related businesses would occur with reduction in fuel load over time and maintenance (through reintroduction of fire as a natural process) of biodiversity that attracts ecotourists.

Alternative 2: Limited Prescribed Fire

Impact Analysis: Suppression activities would affect tourism during peak fire and tourist season under Alternative 2 more than under the No Action Alternative and Alternative 1. With the most suppression, Alternative 2 minimizes duration of fire- related inconveniences in the short- term. Potential for increase in intensity and duration of park closures and visitor inconvenience grows over the long- term, with continued fuel accumulation. The direct effect of suppression and fuel buildups is the possibility of larger fire events that will increase visitor inconvenience in the future. The indirect effects are the same as the No Action Alternative.

Mitigation measures include the potential for timing the few prescribed burns to minimize tourism impacts and educate the public on the benefits of fire as a natural process.

Cumulative Effects: Cumulative effects are similar to the No Action Alternative. With limited prescribed burning, the potential for timing fire activities to minimize tourism impacts is reduced.

Conclusion: Alternative 2 minimizes direct effects to local businesses in the short- term, with minor impacts to local tourism- related businesses expected. Potential continues for short- term adverse impacts to tourism during periods of severe fire conditions, but they are minor in intensity due to availability of other destinations in the region. Potential for greater impacts to tourism exists in the future relative to the other two alternatives. With continued fire suppression within the park and region, the potential for large fires in the park grows, possibly with moderate direct adverse effects on tourism in the future.

Impact Topic 4 (Cultural Resources)

Cultural resources are subject to adverse effects from exposure to flames, heat and smoke, as well as ground disturbance from suppression activities or post- fire erosion (Jones and Euler 1986, Traylor et al. 1990, Lentz et al. 1996). These effects are not generally reversible; historic wooden structures do not grow back after a fire to become what they were before, and disturbed lithic and ceramic scatters do not rearrange themselves into their original positions. Thus, it is important that the fire program be designed to avoid impacts to cultural resources.

The literature primarily contains analyses conducted after wildland fires and a few experimental studies conducted as part of prescribed burns. It is not surprising that intensity of impacts increases with temperature and duration of the fire. Lentz et al. (1996), in their study of impacts to archeological resources following the Henry Fire in New Mexico, recorded substantial fire effects on artifacts under all fire intensities. The recorded damage to artifacts was as deep as 20 cm subsurface. Fuel loading was the critical variable in the severity of these effects.

Appendix C is the cultural resources matrix prepared for the NHPA §106 consultation process, which identifies resources, risks, and mitigation measures. Though only approximately 10 percent of the park has been inventoried (see Chapter III), undiscovered cultural resources are highly likely to fall into matrix categories. Priorities include minimizing ground- disturbing suppression activities and removing fuel loads to reduce effects of fire on known archeological resources and historic properties. In the long- term, it is believed that cultural resources may benefit from the reduced risk of high-severity wildland fire, which has a much greater potential to undermine the integrity of such resources. The matrix and CRC were submitted and approved by the New Mexico SHPO.

Although Carlsbad Caverns National Park has an important museum collection, it is not discussed in depth here as it is not generally affected or threatened by wildland or prescribed fire management practices. However, actions associated with implementation of elements of any one of the alternatives could indirectly affect the collection. Such changes would typically involve additions to the collection generated from archeological data recovery conducted as mitigation for direct site impacts.

Alternative 2 may offer the best short- term protection from direct impacts of fire because it calls for the most suppression, but it also holds more potential for suppression- related damage. Alternative 1 would bring the best long- term protection by reducing fuel loads and the likelihood of widespread fires in the future. The use of cultural resource experts on- site during fire operations is a mitigation tool under all alternatives.

Cultural Resources Intensity of Effects Defined

Negligible: Impacts would be barely perceptible changes in significant characteristics of historic properties, archeological sites, and cultural landscapes.

Minor: Impacts would be perceptible and noticeable, but would remain localized and confined to a single element or significant characteristic of a historic property, archaeological site, or cultural landscape (such as a single archeological site containing low data potential within a larger archeological district or 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 historic properties, archaeological sites, and cultural landscapes.

Major: Impacts would result in substantial and highly noticeable changes in significant characteristics of historic properties, archaeological sites, and cultural landscapes.

Duration of impacts to cultural resources from fire activities is not usually considered under the NHPA. Most direct effects to resources are adverse and permanent. However, landscapes may well recover and even benefit from the effects of fire and fuel reduction.

Assessment Methodology

The cultural resources matrix (Appendix C) is the basis for the analysis. This matrix describes the resources, risks, and treatments to minimize impacts and was developed by management, fire, natural resource, and cultural resource staff of Carlsbad Caverns National Park.

To comply with requirement of NEPA and NHPA §106, the following terms will be used in the analysis to determine effects of the various alternatives and the preferred alternative on the cultural resources that are listed on the National Register of Historic Places.

No Effect: There will be no short- term or long- term effect to listed cultural resources or scenery resulting from the activities under the alternative being addressed.

No Adverse Effect: There is an effect to these cultural resources or scenery, but the effect would not harm those characteristics that qualify the property for inclusion on the National Register of Historic Places.

Adverse Effect: An effect diminishes the integrity of the characteristics that qualify the property or scene for inclusion on the National Register of Historic Places. The cultural resources matrix (Appendix C) is the basis for the analysis.

No Action Alternative: 1995 FMP

Impact Analysis: Careful timing of prescribed burns to avoid peak fire season can minimize impacts to cultural resources. Wildland fire use can reduce fuels in areas where resources can tolerate low- to moderate- intensity fires. Fuel treatment can reduce effects in particular areas. Fuels surrounding cultural resources generally determine duration and intensity of heat exposure. Where heavy fuels are present, fire may expose previously unknown artifacts obscured by vegetation; duration of exposure will vary with vegetation recovery rate. Fuel treatment and wildland fire use will reduce intensity and duration of future effects. The potential for adverse direct impacts exists. Heat and smoke may damage some resources, but the potential for adverse impacts is expected to decrease over time with a reduction in fuel load. Long- term benefits to cultural resources accrue from the reduction in fuel loads in and around sites. Erosion can cause moderate indirect impacts to cultural resources. In addition, exposure of previously unknown sites obscured by vegetation may result in increased vandalism. Fire may help return cultural landscapes to pre- suppression era states.

Mitigation measures locate and identify sites vulnerable to fire effects; mechanically reduce hazardous fuels; construct firebreaks around sites; use minimum impact management techniques; and ensure presence of cultural resource experts during fire operations.

Cumulative Effects: Cumulative effects on cultural resources include concerns within the park only. Based on the list of related activities appearing at the beginning of this chapter, the cumulative effect analysis finds:

- Past and future fire management activities at Carlsbad Caverns may add minor adverse effects on cultural resources, but fuels reduction will reduce long- term risks of damage from wildland fire. Repeated backcountry fires have likely already compromised fire- intolerant artifacts. Cumulative effects on the totality of archeological resources are expected from repeated suppression actions and from construction activities within the park.
- Renovation of the visitor center, resurfacing of its parking lot, and renovation of the main road may have minor adverse effects on cultural resources.

- Replacement of the sewer line may add negligible to minor adverse effects on cultural resources.

Conclusion: Minor direct and indirect adverse impacts to cultural resources would occur. Examples of direct effects include exposure of sites or artifacts through removal of concealing vegetation; cracking and flaking of stone or concrete foundations; alteration of landscapes; and burning of flammable resources, including structures. The main predicted indirect effect is erosion and damage to the integrity of resources after suppression- related disturbances. Cumulative impacts to cultural resources from past, present, and future suppression activities would decrease in relation to Alternative 2.

Because there should not be major impacts to a resource or a value whose conservation is (1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of Carlsbad Caverns National Park; (2) key to the natural or cultural integrity of the park, or (3) identified as a goal in the park's GMP or other relevant NPS planning documents, there should not be impairment of cultural resources under this alternative.

Alternative 1: Full Toolbox

Impact Analysis: The context, intensity, and duration is the same as the No Action Alternative. The direct effects of Alternative 1 are similar to the No Action Alternative and have the smallest potential for disturbance of unknown sites because of ground- disturbing suppression actions. The indirect effects are also similar to the No Action Alternative. Alternative 1 carries the greatest potential for fuel load reduction that can moderate indirect effects.

Mitigation measures are the same as the No Action Alternative.

Cumulative Effects: The cumulative effects are similar to the No Action Alternative, except Alternative 1 should result in fewer impacts to cultural resources from suppression activities.

Conclusion: Minor direct and indirect adverse impacts to cultural resources would occur as described above for the No Action Alternative, with long- term benefits to cultural resources from reduction in fuel loads in and around sensitive areas throughout the park and less damage from fire suppression. Cumulative impacts to cultural resources from fire management activities over time would decrease in relation to Alternative 2.

Because there should not be major impacts to a resource or a value whose conservation is (1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of Carlsbad Caverns National Park, (2) key to the natural or cultural integrity of the park, or (3) identified as a goal in the park's GMP or other relevant NPS planning documents, there should not be impairment of cultural resources under this alternative.

Alternative 2: Limited Prescribed Fire

Impact Analysis: The timing, intensity and duration are similar to the No Action Alternative; however, Alternative 2, does not permit wildland fire use as a management tool. Suppression occurs whenever fire occurs, most commonly during fire season. Alternative 2 also lacks extensive fuel treatment and wildland fire use to reduce effects in the future. Potential exists for adverse impacts. Direct effects of ground- disturbing activities are likely greater under this alternative because it includes the most suppression. Under this suppression- focused alternative, adverse indirect effects are expected due to vegetation loss and erosion. Risks of adverse impacts from high- severity fire continue as fuels build. This alternative offers only limited restoration of cultural landscapes to pre- suppression era status.

Cumulative Effects: The cumulative effects are similar to the No Action Alternative, except Alternative 2 may result in increased impacts to cultural resources from increased high- intensity fire.

Conclusion: Moderate cumulative impacts resulting from successive suppression actions are expected. This alternative, with suppression over most of the park, holds the greatest potential for impacts to cultural resources in the long- term, particularly damage to archeological sites from fire suppression. However, such suppression activities also hold the potential for minimizing damage to cultural resources as well.

Because there should not be major impacts to a resource or a value whose conservation is (1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of Carlsbad Caverns National Park, (2) key to the natural or cultural integrity of the park, or (3) identified as a goal in the park's GMP or other relevant NPS planning documents, there should not be impairment of cultural resources under this alternative.

Impact Topic 5 (Changes in Landscape- Scale Vegetation Patterns)

Concern about landscapes comes from a mixture of sources. Visitors and other stakeholders expect the park to look a certain way, based on what they have seen in person or in photographs. Such expectations lead to the desire for the landscape to remain static. There may even be constituencies that desire park landscapes to look like they did during important historical events.

The fire program at Carlsbad Caverns National Park intends to have landscape- level effects on vegetation while maintaining mosaics. Reducing fuels and maintaining fire as a landscape- scale environmental process are management priorities. Some vegetation types at the park naturally experience stand- replacing fires. In a park managed for its scenic beauty, large- scale stand replacement is not necessarily desirable. These events may also bring unpredictable amounts of erosion. It is desirable to control the application of fire in certain areas to avoid large- scale stand replacement, while still allowing much needed burning to take place—a challenging task.

Park managers will take care to prevent intense fires that may significantly alter Rattlesnake Springs and canyon- bottom riparian areas. These places are historically not particularly fire prone, due to the presence of plentiful moisture, but drought conditions combined with adjacent slopes covered with chaparral overdue for fire place such woodlands at risk. The use of fire in desert shrublands is also controversial. Experts do not agree on historical fire cycles or what might have been the extent and severity of historic fires in shrublands. It is known that fire effects on different plant species are highly variable (see Appendix G).

At Carlsbad Caverns National Park, vegetation types are distributed in a mosaic pattern (i.e. patchy in extent) due to numerous environmental conditions, such as topography, precipitation and soils. The distribution of vegetation on the landscape naturally changes over time with gradual processes like erosion or climate change. Disturbance events, like fires and floods, also rearrange vegetation distributions. Stand- replacing fire regimes, such as occur naturally in shrublands and grasslands, can create dramatic changes in scenery. Also, large intense fires can remove vegetation from large expanses of landscape, potentially erasing mosaic patterns and causing conversions from one vegetation type to another (e.g., from shrubland to grassland). However, the rockiness and irregular topography that influence vegetation mosaics at the park serve to limit the extent of most fires that occur; it would take exceptionally heavy fuel accumulations to sustain large high- intensity fires capable of landscape- level alteration. Large wind- driven fires in the park, such as the Big Fire in 1990, burn extensive areas very quickly, without causing type conversions. These fires reduce fuel accumulations that may otherwise contribute to landscape- altering fires.

Alternative 1, which maximizes wildland fire use and fires crossing boundaries, would reduce the potential for landscape- altering events more than the other two alternatives.

Changes in Landscape- Scale Vegetation Patterns Intensity of Effects Defined

Negligible: Impacts would be barely perceptible changes to landscape features.

Minor: Impacts would be perceptible and noticeable, but would remain localized and confined to a single element or significant characteristic of a landscape, such as a particular plant community over a small area.

Moderate: Impacts would be sufficient to cause a noticeable but not substantial change in landscape features, such as alteration of a particular plant community in several localized areas.

Major: Impacts would result in substantial and highly noticeable changes in landscape features, such as complete loss of vegetation over a widespread area.

Short- term: A return to pre- event arrangement of vegetation on the landscape within the natural fire interval of the affected habitat.

Long- term: No return to pre- event arrangement of vegetation on the landscape within the natural fire interval of the affected habitat.

Assessment Methodology

Assessment of change in landscape- scale vegetation patterns comes from past experience in the park's fire program, park staff expertise, and literature pertaining to fire in the Chihuahuan Desert.

No Action Alternative: 1995 FMP

Impact Analysis: The extent and severity of impacts to vegetation patterns are dependent on fire locations, fuel load, season of burning, and severity of fire conditions (drought, fuel moisture, temperature, wind). Timing and mitigation actions will minimize the degree of change to vegetation patterns. Intensity and duration vary according to season and fire conditions. Fire is a natural disturbance in some vegetation communities and effects subside with each post- fire season given adequate precipitation. Low- to moderate- intensity fires result in minimal risk of adverse impact. Low- to moderate- intensity prescribed fire and wildland fire use thins overgrown vegetation, enhances grass cover, and improves natural mosaic pattern. Short- term scenes of burned landscape are not visually pleasing, but reductions in fuel loads is a direct beneficial effect. This alternative is effective at reducing the indirect effects of widespread future adverse erosion resulting from high-severity wildland fire.

Mitigation measures reduce fuels in areas of high fuel accumulation to avoid high- severity fires; minimize future fire extent by conducting burns to maintain a natural mosaic pattern; and time fires to minimize intensity and duration to limit damage to vegetation.

Cumulative Effects: Cumulative effects on landscape- scale vegetation patterns include concerns within and on lands surrounding the park that serve as pools of colonization for park plant species. Based on the list of related activities appearing at the beginning of this chapter, the cumulative effect analysis finds:

- Past and future fire management activities at Carlsbad Caverns may add short- term minor adverse effects on landscape- scale vegetation patterns. Fuels reduction will reduce long- term

risks of damage from wildland fire and allow fire to safely resume its natural role as a landscape- shaping process and create mosaics of burned and unburned areas, all minor to major beneficial effects.

- Wildland and prescribed fires on nearby lands may have a minor short- term adverse effect on landscape- scale vegetation patterns, but fuels reduction will reduce long- term risk of wildland fire, allow fire to safely resume its natural role as a landscape- shaping process, and create mosaics of burned and unburned areas, all minor beneficial effects on park landscapes.
- Past grazing activities probably had a minor to moderate long- term effect on landscape- scale vegetation patterns, but pregrazing data do not exist.
- Global climate change, drought, fire on adjacent lands, plant diseases, and spread of exotic plants shape landscape- scale vegetation patterns. When combined with fire, increased pressure from these forces could alter vegetation patterns.
- Overall, prescribed burns allow natural fire to resume its role in ecosystems with beneficial effects.

Conclusion: Any potential adverse effects to landscape- scale vegetation patterns are minor in the short- term. Minor to moderate long- term benefits are expected as natural landscapes are restored. Criteria permitting prescribed fire and wildland fire use are designed to maintain or enhance park resources and reduce fuels. The threat of high- severity fire is lessened in the long- term as resource objectives for fuel reduction are met.

Because there would be no major impacts to a resource or value whose conservation is (1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of Carlsbad Caverns National Park, (2) key to the natural or cultural integrity of the park, or (3) identified as a goal in the park's GMP or other relevant NPS planning documents, there would be no impairment of landscape-scale vegetation patterns under the No Action Alternative.

Alternative 1: Full Toolbox

Impact Analysis: The context is the same as the No Action Alternative. Intensity and duration are similar, except there would be a further reduction in risk of high- intensity fire with increased wildland fire use and more treatment along the boundary. The direct and indirect effects are also similar, except the likelihood of large- scale fire decreases with increased prescribed burning and wildland fire use, which in turn reduces the potential for indirect effects.

Mitigation measures are the same as the No Action Alternative.

Cumulative Effects: Cumulative effects are the same as the No Action Alternative.

Conclusion: The effects of Alternative 1 would be the same as the No Action Alternative, but with greater reduction in fuel conditions park- wide that would decrease the long- term threat of landscape- altering wildland fires.

Because there would be no major impacts to a resource or value whose conservation is (1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of Carlsbad Caverns National Park, (2) key to the natural or cultural integrity of the park, or (3) identified as a goal in the park's GMP or other relevant NPS planning documents, there would be no impairment of landscape-scale vegetation patterns under Alternative 1.

Alternative 2: Limited Prescribed Fire

Impact Analysis: The context and timing is the same as the No Action Alternative. Maximum suppression may preclude high- intensity, long- lived direct landscape effects in the short- term, but increases their likelihood in the long- term. Continued fuel loading increases risks of moderate alteration of landscape- scale vegetation patterns by large- scale, high- intensity fires in the future. Alternative 2 is the least effective at reducing the threat of future high- severity wildland fire impacts to vegetation patterns in the park and thus offers the greatest potential for the indirect effects of erosion.

Mitigation measures are the same as the No Action Alternative.

Cumulative Effects: Alternative 2 holds the greatest potential for long- term cumulative effects with increasing risk of future high- intensity fire.

Conclusion: Suppression is capable of causing moderate landscape- scale changes in vegetation patterns. Lack of fire may have maintained shrublands where grasslands once occurred and created dense thickets out of historically open woodlands. Alternative 2 is also least effective at mitigating the threat of future high- severity wildland fire because it allows the most fuel buildup. Maximum suppression under this alternative creates the potential for moderate changes to landscape- scale vegetation patterns.

Impact Topic 6 (Wildlife Habitat Change)

Changes to wildlife habitat from fire program activities are related to effects on plants. Appendix G reviews the effects of fire on selected plant species in each of the five structural types. Fire effects data show general tolerance of fire in the long term, either through resprouting of topkilled stems or fire-induced germination. Exclusion of fire, among other factors, probably has led to significantly altered vegetation composition and density at Carlsbad Caverns National Park and elsewhere in the region (York and Dick- Peddie 1969, Kittams 1972, Wright 1990, Paysen et al.2000). Continued absence of fire will increase fuel loads that make future high- intensity fires, and thus the potential for wildlife habitat change, more probable.

It is known from the scientific literature that fires can potentially injure or kill animals; and large intense fires are certainly dangerous to animals caught in their path (Bendell 1974, Singer and Schullery 1989). However, direct mortality from fire is generally considered to be minor (Ganey et al. 1996), with season of burn having a significant impact on mortality (Kruse and Piehl 1986, Lehman and Allendorf 1989, Robbins and Myers 1992). For example, burning during nesting season appears to be most detrimental to bird and small mammal populations (Erwin and Stasiak 1979).

Habitat effects can have more bearing on wildlife than direct mortality (Singer et al. 1989, Vales and Peek 1996). Fires influence animal species indirectly due to habitat modification, changes in food supply, or changes in abundance of competitors and/or predators (Rotenberry et al. 1995, Finch et al. 1997). A review by Finch et al. (1997) points out that reproductive success may be reduced in the first postfire year because of food reductions from spring fires. Thus, changes in vegetative structure and compositions have interlinking effects on the dependent faunal species.

Fires can impact birds positively or negatively, depending on the season, patchiness, severity of burn, and the particular behavior strategy of the species involved (Kruse and Piehl 1986; Lehman and Allendorf 1989; Robbins and Myers 1992). Ground- nesting birds are at risk during nesting season fires, but their nesting success increases when fire burns habitat in a mosaic pattern (Kruse and Piehl 1986). Patchy burns also favor species that require perches and cover above the ground (Bock and

Bock 1990). At Carlsbad Caverns, this kind of fire behavior might be expected just before the predicted onset of the monsoon season, around the first of July.

Raptors benefit from decreases in cover and exposure of prey. Dodd (1988) noted that the northern harrier, American kestrel, red- tailed hawk, Cooper's hawk, and turkey vulture are attracted to fire and recent burns. When prey species increase in response to postfire increases in forage, raptors are also favored. Dodd (1988) describes beneficial effects from fire on populations of burrowing owl in desert grassland, sharp- shinned and Cooper's hawk in desert scrub, and northern goshawk and sharp-shinned hawk in ponderosa pine forest.

Low- to moderate- intensity prescribed fire and wildland fire use under Alternative 1 and the No Action thin crowded stands, maintain habitat mosaics, and reduce fuel loading that contributes to high- severity wildland fire. Alternative 1, therefore, provides the greatest benefit to wildlife habitat.

Wildlife Habitat Change Intensity of Effects Defined

Negligible: The impact on wildlife habitat is at the lowest levels of detection, barely perceptible and not measurable.

Minor: An action that could cause a change to wildlife habitat but the change would be small and, if measurable, it would be a localized effect limited to a small area of the park.

Moderate: An action that could cause a change to wildlife habitat in the park. The impact is measurable and perceptible, having adverse or beneficial impact. The change would be a localized effect and not be considered a threat to wildlife habitat in the long- term.

Major: The impact is substantial, noticeable and permanent. The impact could decrease the *species diversity* of the park, be considered a threat to the long- term survivability of populations in question, and/or eliminate the population of a species that is locally endemic or considered key to the natural integrity of the park. The impact could also be an action that would improve wildlife habitat by an increase in species diversity or population numbers of particular species.

Short- term: An effect that within a short period would no longer be detectable as the resource is returned to its predisturbance condition or appearance, generally less than 5 years.

Long- term: A change in a resource or its condition that does not return to predisturbance condition or appearance and for all practical purposes is considered permanent.

Assessment Methodology

Impacts of the fire program on landscape- scale vegetation patterns have been developed from the literature and the experiences of staff and outside experts.

No Action Alternative: 1995 FMP

Impact Analysis: Prescribed fire provides more control over timing and location of effects. There is less control of timing with lightning ignitions for resource benefits, although prescriptions can include such factors as season. Fire effects, and understanding of effects, vary with habitat. The intensity and duration of impacts vary with time of year and fire conditions.

Direct effects on wildlife habitat include mortality to individual plants; topkill and resprouting of plants; thinning of stands; flushes of germination; and temporary effects from smoke. These effects vary with season, fuel loads, and weather. Prescribed fire and wildland fire use, both constrained by

prescriptions, provide more control over effects—species adapted to natural season burns are less at risk from wildland fire use for resource benefits. For wildlife, direct effects on vegetation translate into indirect effects of loss of cover, forage and nest sites, but also pulses of food availability with renewal and recolonization of burned areas. Potential for high- intensity wildland fire is reduced with reduction in fuel loads. Low- intensity fire establishes natural fuel breaks, minimizing the extent of future fires.

Mitigation measures can reduce intensity and duration of impacts. These measures monitor wildlife habitat fire effects; suppress and/or reduce fuels in or around unique or fire- susceptible areas; time fires to minimize intensity; use minimum impact management techniques; plan for burning in a mosaic pattern; and rehabilitate burned areas.

Cumulative Effects: Cumulative effects on wildlife habitat include concerns within and on lands surrounding the park that also serve as habitat for mobile park species. Based on the list of related activities appearing at the beginning of this chapter, the cumulative effect analysis finds:

- Past and future fire management activities at Carlsbad Caverns may add short- term minor adverse effects on wildlife habitat (loss of cover), but new growth is a short- term beneficial effect. Fuels reduction will reduce long- term risks of damage from wildland fire and allow fire to safely resume its natural role as a habitat- renewing process, and create mosaics of burned and unburned areas, all minor to major beneficial effects.
- Wildland and prescribed fires on nearby lands may have a minor short- term adverse effect on wildlife habitat (loss of cover), but new growth is a short- term beneficial effect. Fuels reduction will reduce long- term risk of wildland fire, allow fire to safely resume its natural role as a habitat- renewing process, and create mosaics of burned and unburned areas, all minor beneficial effects on wildlife habitat.
- Past grazing activities probably had a minor to moderate long- term effect on wildlife habitat, but pregrazing data do not exist.
- There can be re- establishment of natural fire mosaics and reduction in fuel loads on a large scale with fire activities on adjoining national forest and BLM lands. These activities reduce potential for major habitat- altering, high- severity fire events.

Conclusion: By using mitigation measures, the potential for adverse impacts to wildlife habitat is minimized in both the short- and long- term. Careful prescriptions can minimize adverse effects even while allowing wildland fires for resource benefit to occur. Increased wildland fire use for resource benefit would affect plants and animals intolerant of fire, but would benefit fire- adapted species in the long- term.

Because there would be no major impacts to a resource or value whose conservation is (1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of Carlsbad Caverns National Park, (2) key to the natural or cultural integrity of the park, or (3) identified as a goal in the park's GMP or other relevant NPS planning documents, there would be no impairment of wildlife habitat resources from the No Action Alternative.

Alternative 1

Impact Analysis: The timing is similar to No Action Alternative. Maximum wildland fire use and cross- boundary burning under Alternative 1 reduces the likelihood of future high- intensity fires in affected areas. The intensity, duration, and direct effects are the same as the No Action Alternative. Although similar to the No Action Alternative, the indirect effects of Alternative 1 hold the greatest potential for fuel load reduction.

Mitigation measures are the same as the No Action Alternative.

Cumulative Effects: Cumulative effects are the same as the No Action Alternative.

Conclusion: Alternative 1 is similar to the No Action Alternative, but with the greatest reduction in potential for adverse effects to wildlife habitat in the long term as fuel loads are reduced.

Because there would be no major impacts to a resource or value whose conservation is (1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of Carlsbad Caverns National Park, (2) key to the natural or cultural integrity of the park, or (3) identified as a goal in the park's GMP or other relevant NPS planning documents, there would be no impairment of wildlife habitat resources from Alternative 1.

Alternative 2

Impact Analysis: Alternative 2 will see greater frequency of suppression- related impacts to wildlife habitats. The absence of wildland fire use for resource benefits and limited prescribed fire will lead to continued fuel buildup in all areas. Susceptibility to large- scale wildland fire increases, potentially reducing wildlife habitat mosaics. The intensity and duration are similar to the No Action Alternative. Under Alternative 2, fuel loading that could lead to high- severity wildland fire will likely continue. Alternative 2 minimizes fire- related direct effects, but maximizes suppression- related disturbances. It brings continued potential for high- severity wildland fire with extreme impacts to wildlife habitat in the long- term. Alternative 2 causes the most suppression- related disturbance since there is no wildland fire use for resource benefits and limited prescribed fire. Both short- term adverse and long-term beneficial indirect effects are minimized. Potential for high- severity wildland fire with extreme impacts to wildlife habitat continues.

Mitigation measures are the same as the No Action Alternative.

Cumulative Effects: Cumulative effects are the similar to the No Action Alternative. Wildland fire use and fuel treatment outside the park can moderate potential for high- severity wildland fire.

Conclusion: This alternative applies the most suppression and mechanical fuel reduction, minimizing both fire's adverse and beneficial effects to wildlife in the short term. Long- term risk of high intensity fire grows as fuel loading increases.

Alternative 1 is similar to the No Action Alternative, but the potential for adverse effects to wildlife habitat are greatly reduced in the long term as fuel loads are reduced.

Because there would be no major impacts to a resource or value whose conservation is (1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of Carlsbad Caverns National Park, (2) key to the natural or cultural integrity of the park, or (3) identified as a goal in the park's GMP or other relevant NPS planning documents, there would be no impairment of wildlife habitat resources from Alternative 2.

Impact Topic 7 (Special- Status Species)

Chapter III introduced the park's special- status species that require consideration during the fire planning process. The BA prepared for the USFWS analyzed the effects of the plan on three federally listed species: Lee pincushion cactus, Sneed pincushion cactus, and Mexican spotted owl.

An analysis of the potential effects of the alternatives on each special- status species follows. Under Alternative 1, two treatment zones have goals of determining fire effects on Mexican spotted owl.

These two zones are termed the wildland fire use study area and the Walnut Canyon prescribed fire zone. In addition, the escarpment prescribed fire zone, an active prescribed management zone, potentially includes Mexican spotted owl habitat.

Special- Status Species Intensity of Effects Defined

Negligible: An action that could affect individuals of a species, but not cause measurable or perceptible change to populations of sensitive species.

Minor: An action that could cause a change to populations of sensitive species, but the change would be small and, if measurable, it would be a small and localized effect and not decrease or increase the long- term survivability of sensitive species.

Moderate: An action that could cause a change to populations of sensitive species such that the species diversity of the park is decreased or increased. The change would be a localized effect and not considered a threat to the long- term survivability of species in question.

Major: An action that could decrease the species diversity of the park, be considered a threat to the long- term survivability of populations in question, and/or eliminate the population of a species that is locally endemic or considered key to the natural integrity of the park; or an action that would increase species diversity or increase the population of a particular species.

Short- term: Distribution and abundance of sensitive species returns to pre- event range of variability within the natural fire interval of the affected habitat.

Long- term: Distribution and abundance of sensitive species does not return to pre- event range of variability within the natural fire interval of the affected habitat.

Assessment Methodology

Impacts of the fire program on special- status species have been developed from research and monitoring results within the park, literature, and experiences of staff and outside experts. Work with the USFWS on the BA produced conclusions about the three federally listed species.

Federally Listed Species

The BA analyzed the effects of a worst- case scenario, addressing the most intensive treatment level possible. That level is not likely to be implemented. Conservation measures listed in the BA will be required under all alternatives in all project areas with Mexican spotted owl and pincushion cactus habitat. This requirement reduces the effects of fire program implementation. These measures include:

- Conduct project- specific surveys in all suitable cactus and owl habitats before doing prescribed fires.
- Make all relevant fire management agencies and firefighters aware of the management plan before a fire occurs.
- Seek funding to do a variety of fire ecology studies, including studying fire effects on the pincushion cacti. For such a study, certain plots would be burned and monitored. All vegetative manipulations in occupied or restricted habitat should follow restrictions in the owl recovery plan. Fire may be beneficial in the long term for the two cactus varieties, but no studies have shown this. When funding is acquired, the park would like to have a researcher design a study of fire effects on seedling recruitment among these tiny cacti.

- Keep any vegetative manipulations in occupied or restricted habitat commensurate with the owl recovery plan.
- Seek funding to conduct owl surveys following USFWS protocols. After occupied sites are known, a more comprehensive fire evaluation and response plan will be developed, including restoration actions if needed.
- Minimize fireline construction, clearing, and scraping.
- Use water drops instead of fire retardant where practical.
- Use natural barriers for fire lines whenever possible.
- Dispatch resource advisors to all fires.

Lee pincushion cactus and Sneed pincushion cactus (*Coryphantha sneedii* var. *leei* and *Coryphantha sneedii* var. *sneedii*): Sneed pincushion is grouped with the Lee pincushion assessment, since the closely related varieties are probably similarly affected by fire. The likelihood that the two cacti will be found in any prescribed or wildland fire area is high. Due to direct and indirect effects to cacti, it is the determination that the proposed action is likely to adversely affect the Lee and Sneed pincushion cacti.

Wildland fire use and prescribed fires, as well as mechanical treatments, will and already have negatively affected *Coryphantha sneedii*. Given the presence of both varieties of *Coryphantha sneedii* in fire- prone park habitats, it is likely that populations have persisted over time through repeated fire events. Regular, low- intensity fire may help prevent fires that cause mortality by reducing woody fuels surrounding the cacti that burn hotter than grasses.

Two park monitoring studies conducted on Lee pincushion cactus evaluated mortality of the species following a fire. In both studies, almost 20 percent of the cacti either perished immediately or suffered fire- caused injuries that resulted in mortality over the three years of data collection (Dobos- Bubno et al. 1997). Some causes of mortality were the direct exposure to heat and flame, retention of heat in surrounding vegetation, and burning vegetation rolling downslope onto and near individuals. The recovery plan (USFWS 1986) identifies trampling as a potential effect. Prescribed fire preparation methods (blackline operations, firefighter off- trail movement, aerial incendiary devices, cultural resource protection actions) and wildland fire suppression methods (line construction, backburning, air tanker/helicopter water drops, water drop surfactants, fire- retardant drops, water tender use, cultural resource protection actions, firefighter off- trail movement) will directly affect any cacti in the area. It is unknown what fire intensity best reduces negative direct effects. However, in all likelihood, the higher the fire intensity, the greater the adverse effects due to increased direct mortality.

Indirect, short- term effects found in the monitoring studies mentioned above include mortality due to soil deposition resulting from post- fire erosion and reduced reproductive capability. Viability, or flowering capability, was reduced for two years following fire. Other indirect effects may include loss of plants from root exposure due to soil loss at the individual site and loss of immediate surrounding vegetation that may shade or host the plant. Studying recruitment (reproduction) would be important for more information.

Both Sneed and Lee varieties flower in April and May, with fruit production in late summer. Prescribed fires planned just before or during flowering season may affect reproductive capability, as data seems to suggest. Prescribed and wildland fires burning during the appropriate season may not affect reproductive capability as these are natural events with which the cacti may have evolved. However, to avoid the extreme weather conditions that come with the natural summer fire season,

prescribed burns at the park have taken place mostly in the spring and fall. No data exist on impacts of fire during the fruit production season nor do data exist on the impacts of fire to fruits.

Fire may have a positive indirect effect by reducing immediate plant competition or improving other vegetation and wildlife elements specific to the needs of the cacti. These effects remain unknown for this assessment.

Mexican spotted owl (*Strix occidentalis lucida*): All three of the FMP alternatives have the potential to adversely affect individual owls and Mexican spotted owl habitat. Activities associated with wildland fire suppression, prescribed burning, and thinning treatments can directly affect nesting or resident Mexican spotted owls through auditory or visual disturbances. Helicopter and air tanker overflights can occur during any fire- related activity. These disturbances can disrupt activities, such as breeding, feeding and roosting. Adults and fledged young may be flushed from their nesting or roosting areas due to prescribed burning activities and wildland fire suppression efforts. Smoke from fires during the breeding season can cause mortality of owls (particularly young) by burning or by carbon monoxide poisoning. All of these activities, if they occur during the breeding season, may result in nest abandonment or reduce reproductive success. Prescribed burning or thinning activities may indirectly affect the Mexican spotted owl by changing the owl's habitat structure (i.e. snags, downed logs, woody debris, multi- storied canopies, dense canopy cover), potentially resulting in the displacement of owls. In addition, certain treatments, especially prescribed burning and wildland fire use, may change the structure of Mexican spotted owl prey species' habitat, affecting the abundance and composition of prey species. Prescribed burning and wildland fire use may also increase the diversity of vegetative conditions that in turn provide for a diverse prey base.

The Mexican spotted owl recovery plan recognizes catastrophic fire as a primary threat. Despite the adverse effects to the Mexican spotted owl and its habitat from the activities proposed, the cumulative loss of Mexican spotted owl habitat from high- severity wildland fires possible under Alternative 2 could be greater and have potentially increased adverse impacts to the species than would the implementation of the NPS- preferred alternative, Alternative 1.

Other Special- Status Species

The southwestern willow flycatcher, a federally endangered species, is only known as a migrant at the park, specifically in the Rattlesnake Springs area. Because it does not nest in the park, it is unlikely to be affected by fires or fire management activities. A fire at Rattlesnake Springs could adversely impact the state- endangered blotched watersnake, state- threatened greenthroat darter, and state- threatened Rio Grande cooter, if the clear water they require becomes fouled. The state- threatened varied bunting, Bell's vireo, and gray vireo could also be impacted if the vegetation they nest in is destroyed by fire.

A high- intensity fire could potentially adversely impact some plant species. Mat leastdaisy is one such species of concern. Guadalupe mescal bean and shining coralroot have very limited distributions, so special care is needed to ensure that a high intensity fire will not eliminate these species.

The mottled rock rattlesnake is a state- threatened species that should be relatively well protected from fire effects because it primarily inhabits rocky areas. Although little is known about the distribution of state- endangered gray- banded kingsnakes in the park, they are generally associated with rocky areas in other places, and are therefore not likely to be severely affected by fires. Many special- status plants can be protected from fire because they occur in rocky areas or other habitats that are less prone to fire; however, under certain conditions, such as high fuel loads, the plants may not be protected. These plant species include Chaplin's golden columbine, yellowseed nama, cardinal

penstemon, five- flowered rockdaisy, Guadalupe milkwort, mountain sage, sparseflower jewelflower, and Guadalupe valerian.

The state- threatened peregrine falcon and Baird's sparrow are thought to be fire- adapted species, and may therefore benefit if there is more fire on the landscape.

No Action Alternative: 1995 FMP

Impact Analysis: Natural- season fires that avoid breeding seasons will cause the fewest negative impacts on plants and animals. However, safety considerations frequently push prescribed burns into pre- and post- fire seasons when risks increase. Fires impact plants less severely in non- drought years. Low- to moderate- intensity fires and mechanical fuel reduction in key areas results in minimal risk of adverse impact. Fire is part of the process for natural sites, and effects subside with each post- fire season. Increased wildland fire use for resource benefit would have minor, short- term direct effects on plants and animals intolerant of fire with mitigation. Prescribed fire and mechanical fuel reduction protect sensitive areas as refuges for animals. The indirect effect is that native species benefit from changes in vegetation structure and composition due to fire, as well as from post- fire increases in resource availability (e.g., light, nutrients, water).

Mitigation measures reduce intensity and duration of impacts. Mitigation measures perform mechanical hazardous fuel reduction to reduce the likelihood of high- severity fire; set prescriptions that protect sensitive species' habitats; staff resource experts during fire operations; and monitor post- fire to verify and improve prescriptions.

Cumulative Effects: Cumulative effects on special- status species include concerns within the park and on nearby lands, including the BLM and USFS. Based on the list of related activities appearing at the beginning of this chapter, the cumulative effect analysis finds:

- Past and future fire management activities at Carlsbad Caverns may add short- term minor adverse effects on special- status species but fuels reduction will reduce long- term risk of wildland fire, allow fire to safely resume its natural role as a habitat- renewing process, and create mosaics of burned and unburned areas—all minor to major beneficial effects.
- Wildland and prescribed fires on nearby lands may have a minor short- term adverse effect on special- status species, but post- fire pulses of forbs (that support prey species) have short- term beneficial effects for Mexican spotted owls.
- Past grazing activities probably had a minor to moderate long- term adverse effect on the pincushion cacti and other special- status plant species and possibly on Mexican spotted owl habitat, but pregrazing data do not exist.
- Ongoing illicit collection has a minor to moderate long- term adverse effect on Sneed and Lee pincushion cacti.
- Fire events in the same location at higher than historical frequency could shift plant and animals to different habitats. Repeated fires minimize long- term potential for high- severity fire.

Allowing prescribed fire and lightning ignitions to reduce fuels poses short- term risks to special- status species, but protection over the long- term from widespread, high- severity fire.

Conclusion: Potential for adverse impacts to special- status species is minimized in the long- term with mitigation measures that reduce adverse effects while allowing wildland fire use for resource benefit to occur. Increased prescribed fire and wildland fire use for resource benefit may have minor to moderate adverse impacts to species in the short term, but should provide long- term benefits.

Because there would be no major impacts to a resource or value whose conservation is (1) necessary to fulfill specific purposes identified in the enabling legislation or proclamation of Carlsbad Caverns National Park, (2) key to the natural or cultural integrity of the park, or (3) identified as a goal in the park's GMP or other relevant NPS planning documents, there would be no impairment of special-status species from the No Action Alternative.

Alternative 1

Impact Analysis: The context of Alternative 1 is similar to the No Action Alternative with future impacts reduced as more fires occur. The intensity and duration of effects are the same as the No Action Alternative. The direct effects are similar to the No Action Alternative except that the potential for high-impact fire subsides over time with more burning. The indirect effects are the same as the No Action Alternative.

Mitigation measures are the same as the No Action Alternative.

Cumulative Effects: Cumulative effects are the same as the No Action Alternative.

Conclusion: Alternative 1 is similar to the No Action Alternative, but with the greatest reduction in potential for adverse effects to special- status species as fuel loads are reduced in the long- term.

Because there would be no major impacts to a resource or value whose conservation is (1) necessary to fulfill specific purposes identified in the enabling legislation or proclamation of Carlsbad Caverns National Park, (2) key to the natural or cultural integrity of the park, or (3) identified as a goal in the park's GMP or other relevant NPS planning documents, there would be no impairment of special-status species from Alternative 1.

Alternative 2

Impact Analysis: In Alternative 2, there is a more limited consideration given to plant ecology/life cycles since fire operations are aimed at fuels reduction only. The few prescribed fires are of minor intensity and duration. The absence of wildland fire use creates a greater frequency of suppression- related impacts and increases the risk of high- severity fire. Maximum suppression will minimize short- term direct adverse effects (death and injury) on plants and animals, but increase long- term risk. This alternative limits beneficial indirect effects of fire on plant and animal habitats.

Mitigation measures are the same as the No Action Alternative.

Cumulative Effects: Continued threat of high- severity wildland fire that may cause severe impacts to plant and animal populations.

Conclusion: Alternative 2 applies the most suppression and mechanical fuel reduction, minimizing fire's adverse and beneficial effects to wildlife in the short- term. Long- term risk of high- intensity fire grows as fuel loading increases.

Because there would be no major impacts to a resource or value whose conservation is (1) necessary to fulfill specific purposes identified in the enabling legislation or proclamation of Carlsbad Caverns National Park, (2) key to the natural or cultural integrity of the park, or (3) identified as a goal in the park's GMP or other relevant NPS planning documents, there would be no impairment of special-status species from Alternative 2.

Impact Topic 8 (Exotic Species)

Information on the interactions involving fire and invasive exotic species is generally lacking and research is needed to increase our understanding of fire effects. However, for some exotic plant species, fire is known to promote spread or invasion into previously undisturbed areas. Fire may prove beneficial in helping to control certain exotic species as well, particularly as a tool to reduce biomass in combination with other treatments.

Of the non- native plants described as priorities in Chapter III, the following are of concern or interest relative to fire program activities. Information comes from communications with park staff, Guertin's (2003) review, and the USFS.

Fire Effects Information System (FEIS)

African rue: African rue is found outside of the park along roads and at disturbed oil field sites. Fuels may not be available to carry fire in these areas. There is concern that the species may spread as fire operations disturb new sites.

Tree of heaven: Tree of heaven (ailanthus) resprouts after fire (Hoshovsky 1988). It is present at Carlsbad Caverns only at Rattlesnake Springs, where it has a sufficient supply of water and can avoid excessively arid conditions that limit growth (Feret 1985).

Field bindweed: Fire is not known to enhance field bindweed spread, but can reduce competitive plant cover and may promote seed germination through scarification. It sprouts vigorously from large rhizomes following fire. Fire in combination with herbicide applications is effective (Swan 1983).

Johnson grass: Deep rhizomes and tendency to grow in wet areas allow it to survive fire. Spring burning may encourage Johnson grass growth.

Klein grass: Klein grass is restricted to Slaughter Canyon. The role of fire in its spread is unknown.

Lehmann lovegrass: Lehmann lovegrass increases in dominance following fire through abundant seedling establishment. The grass has a relatively narrow range of climatic requirements, preferring winter temperatures above 32°F (Uchytil 1992).

Malta starthistle: There is limited information on Malta starthistle's competitive abilities and fire ecology, but DiTomaso and Gerlach (2000) suggest the plant's response to fire would follow that of closely related yellow starthistle, although park staff has observed many differences between the two. Yellow starthistle is killed by moderate- intensity fire (DiTomaso et al. 1999). Timing and frequency of burning are important in determining yellow starthistle's response to fire (Zouhar 2002). Fire creates conditions generally favorable to establishment of yellow starthistle, given the presence of seeds in the soil seed bank or dispersal of seed to the site from an off- site source (Martin and Martin 1999, Zouhar 2002). A fire during the early flowering stage before seeds mature can reduce seed production (DiTomaso and Gerlach 2000) and consecutive, annual fires can result in large reductions in plant cover and seed bank (DiTomaso et al. 1999, Martin and Martin 1999). Since the plants are winter annuals and are present only as seeds during the warm and hot months, they are unlikely to be directly affected by fire.

Puncturevine: Puncturevine (goathead) likes bare areas and could germinate with summer rains following spring fires. It occurs around developed areas, such as the visitor center where burning might be of limited use for fuel reduction.

Russian olive: Information on the effects of fire on Russian olive is lacking. It resprouts from root crown following fire and can colonize burned areas from off- site seed sources (Bovey 1965).

Russian thistle: Burning when succulent and prior to seed maturation may reduce densities of Russian thistle (tumbleweed), but cannot prevent the arrival of seeds from off- site. Return of natives eventually can crowd out Russian thistle. Piled up dry tumbleweeds can be a fire hazard; flaming plants have been known to roll and spread fire.

Scotch thistle: Scotch thistle was eradicated from the park in 1999, but could return. As a colonizer of disturbed areas, it benefits from both suppression activities and creation of bare ground by fires.

White horehound: No information on fire response is found in the literature for white horehound. However, the plant is known to move into eroded areas and fire can lead to erosion. At neighboring Guadalupe Mountains National Park, the 1993 Pine Fire burned hot and fast through a horehound field in an old horse pen. The horehound has not returned (Fred Armstrong, personal communication).

Woolly mullein: Woolly mullein colonizes bare areas, including those resulting from fire, and disturbance brings seeds to the surface (Hoshovsky 1986). An effective preventative method for woolly mullein is the seeding of disturbed areas with natives.

Exotic Species Conclusions

Most exotic species identified in the park are limited to specific locations. Fire is not considered a significant contributor to the spread of exotic species on a park- wide scale. Both suppression activities and fires themselves can create areas favored by exotic species. Appropriate mitigation measures would be undertaken in the event that such species are identified at a site proposed for prescribed burning. Should invasive exotic species become more of a threat to natural ecosystems at the park, more care would be required for fire program activities. Under all alternatives, monitoring exotic species spread because of fire program activities, as well as effects of fire on the plants themselves is warranted.

Exotic Species Intensity of Effects Defined

Negligible: Impacts would be barely perceptible changes in number, distribution, and densities of non- indigenous species.

Minor: Impacts would be perceptible and noticeable, but would remain localized and confined to one or two species or places.

Moderate: Impacts would be sufficient to cause a noticeable, but not substantial change in number, distribution, and densities of non- indigenous species.

Major: Impacts would result in substantial and highly noticeable changes in number, distribution, and densities of non- indigenous species.

Short- term: A return to the pre- event range of variability in distribution and abundance of non-indigenous species within the natural fire interval of the affected habitat.

Long- term: No return to the pre- event range of variability in distribution and abundance of non-indigenous species within the natural fire interval of the affected habitat.

Assessment Methodology

Impacts of the fire program on exotic species have been developed from the literature and the experiences of staff and outside experts.

No Action Alternative: 1995 FMP

Impact Analysis: Season and location of fire will affect impacts on non- indigenous species. Fuel treatment will reduce the threat of high- intensity fires in affected areas. Prescribed burns can be timed to avoid encouraging target non- indigenous species. Most areas of the park are not threatened by spread of target species.

High- intensity fires that result in bare ground attractive to species that colonize such areas can contribute to their spread. High intensity fires may, on the other hand, kill seeds of Malta starthistle and permanently remove horehound. Low- intensity fires may favor native or non- indigenous species depending on time of year. Duration of a fire in a particular area should have negligible effects. The duration of the overall fire event, as an indicator of overall fire size, affects amount of ground potentially disturbed. There are minor direct effects where burning shoots of sprouters stimulates growth, and high- intensity fires may kill seeds of sensitive non- indigenous species. The indirect effects of fires can clear areas and make them attractive germination sites, post- fire erosion of bare areas may further favor exotics, and suppression- activity disturbances create new habitat.

Mitigation measures survey for stand locations; carry out non- indigenous species control and research programs; reduce fuels around areas containing target species; adjust prescriptions to avoid spread of target species; maintain vigilance about seed transport on vehicles; and educate in order to help reduce effects of the fire program on the spread of non- indigenous species.

Cumulative Effects: Cumulative effects on exotic species include concerns within the park and on lands immediately surrounding the park. Based on the list of related activities appearing at the beginning of this chapter, the cumulative effect analysis finds:

- Past and future fire management activities at Carlsbad Caverns may increase long- term minor to moderate adverse effects from the spread of exotic species through the creation of new disturbed areas.
- Wildland and prescribed fires on nearby lands may increase long- term minor to moderate adverse effects from the spread of exotic species through the creation of new disturbed areas. Spread outside the park increases the likelihood of spread into and inside the park.
- Past grazing activities probably had minor long- term adverse effects on the spread of exotic species, but pregrazing data do not exist.
- Visitor center renovation, parking lot resurfacing, main road renovation, and sewer line replacement are all activities that both create new disturbed areas (habitat for exotic plants) and require the service of heavy equipment (transporters of exotic plant seeds); thus these activities would result in minor long- term adverse effects from spread of exotic plants.
- Ongoing education programs that raise public awareness of how exotic plants spread may have a minor beneficial effect; fires and suppression activities in neighboring jurisdictions could facilitate spread by preparing new habitat.

Moderate amounts of prescribed fire and lightning ignitions, together with suppression activities, can create the potential for exotics to spread. These effects would be minimized with the use of mitigation measures.

Conclusions: Under the No Action Alternative, the potential for exotic plant spread exists both from allowing fires to burn, thus clearing areas for colonization, and from disturbing the ground during suppression actions. Because the occurrence of exotics is highly localized in the park and the mitigation measures described above would be applied in all instances where feasible, the No Action Alternative is predicted to have minor short- term adverse effects.

Because there would be no major impacts to a resource or value whose conservation is (1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of Carlsbad Caverns National Park, (2) key to the natural or cultural integrity of the park, or (3) identified as a goal in the park's GMP or other relevant NPS planning documents, there would be no impairment from exotics from the No Action Alternative.

Alternative 1

Impact Analysis: The context of Alternative 1 is the same as the No Action Alternative. The duration and intensity is similar to the No Action Alternative, but less high- intensity fire would leave less area attractive for colonization. The direct effects are also similar to No Action Alternative, but with less high- intensity fire. The indirect effects are the same as the No Action Alternative.

Mitigation measures are the same as the No Action Alternative.

Cumulative Effects: The cumulative effects are the same as the No Action Alternative.

Conclusion: There should be less suppression under Alternative 1 and more wildland fire use, which trades one mode of creating disturbance, which might encourage spread of exotics, for another. Alternative 1 is predicted to have minor short- term adverse effects because the occurrence of exotics is highly localized in the park and the mitigation measures would be applied in all instances where feasible.

Because there would be no major impacts to a resource or value whose conservation is (1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of Carlsbad Caverns National Park; (2) key to the natural or cultural integrity of the park; or (3) identified as a goal in the park's GMP or other relevant NPS planning documents; there would be no impairment from exotics from Alternative 1.

Alternative 2

Impact Analysis: The timing and context is similar to the No Action Alternative except more suppression, which can create disturbances favorable to exotics, will take place in more locations under Alternative 2. Less fire, which may encourage some species and discourage others, will burn over landscapes in the short- term, as risks increase for high- severity fires over large areas with potential fuel buildups. The duration and intensity are also similar to the No Action Alternative, but suppression of all wildland fires may lead to fuel buildups capable of sustaining high- intensity fires to a greater extent than with the other alternatives. The fewest fires are likely under Alternative 2 in the short term; direct effects of fire are more localized with successful suppression. In the long- term, with continued fuel buildups, the likelihood of high- severity fire that may make large areas susceptible to colonization increases, but also kills fire- intolerant exotic species. Indirect effects are similar to the No Action Alternative, but more suppression potentially creates more disturbed areas for colonization by exotics.

Mitigation measures are the same as the No Action Alternative.

Cumulative Effects: Cumulative effects are the same as the No Action Alternative.

Conclusion: Alternative 2 calls for suppression of all ignitions and little prescribed burning. Suppression disturbances potentially prepare more areas for colonization by exotics in the short- term from soil disturbance; high- severity fires potentially prepare areas over the long- term, by removing soil organic matter and overstory, which alters nutrient, water and light conditions. Alternative 2 is also predicted to have minor short- term adverse effects when fire occurs where exotics exist. The mitigation measures described above would be applied in all instances where feasible.

Because there would be no major impacts to a resource or value whose conservation is (1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of Carlsbad Caverns National Park, (2) key to the natural or cultural integrity of the park, or (3) identified as a goal in the park's GMP or other relevant NPS planning documents, there would be no impairment from exotics from Alternative 2.

Table IV- 1. Summary Comparison of Impacts

Impact Area	Overview	No Action Alternative: 1995 FMP	Alternative 1 (Preferred): Full Toolbox	Alternative 2: Limited Prescribed Fire
Issue 1 (Life and Property): Fire is an effective tool for reducing hazard fuels, but can pose a threat to firefighters, park staff, developed areas, and the public.	Safety is the greatest consideration. The FMP dictates actions for contingencies when life and property are threatened. All alternatives would apply non-fire treatments to reduce fuels around sensitive areas only.	Minor, adverse short- term effects would ultimately result in minor, beneficial long- term effects as risks are reduced. Short- term risks to firefighters are increased with more fire use. Long- term threats are slowly moderated as prescribed burning and wildland fire use objectives are met.	Alternative 1 is similar to the No Action Alternative. Initially an increase in wildland fire use would result in short- term minor adverse impacts to public safety and property. This alternative offers the greatest long- term risk reduction as fuels are reduced.	Moderate adverse impacts in the long term as risk of high-severity fire increases over time. Applies the most suppression, resulting in the most risk to firefighters and least to staff, public, and property in the short- term. Higher risk in the long- term as fuel loads continue to increase.
Issue 2 (Park Neighbors): Park neighbors are concerned with fire crossing park boundaries.	Although fire may threaten to burn across boundaries, threatening neighboring property, prescribed burns to reduce fuel loads ultimately minimize risk of wildland fire damage. The park is diligent about informing interested parties of pending burns.	Minor, adverse short- term effects would ultimately result in moderate, beneficial long-term effects as risks are reduced. Reduces risk of fire escaping park boundaries, using collaboration with neighboring land management agencies and private landowners.	Minor, adverse short- term effects would ultimately result in major, beneficial long- term effects as risks are reduced. Best reduces the long- term potential for unwanted fires to escape the park, or enter the park from neighboring lands by reducing fuel loads. Interagency collaboration is needed to implement this option.	Short- term minor to moderate adverse effects from suppression activities. Management actions are dictated to minimize the risk of fires leaving the park. Fuel buildup along the boundary may result in moderate adverse effects in the future.
Issue 3 (Tourism): Local businesses may experience temporary declines in business if park visitation declines due to fire.	Wildland fire use and prescribed fire decrease the chance for catastrophic fire that would affect tourism in a negative way.	Minor, beneficial impacts over the long- term as biodiversity is maintained and fuel loads are reduced. Short- term, adverse effects to local businesses are possible from visitor use restrictions, but effects should be minor due to availability of other local destinations. Intensity of effects is directly related to fire size, severity and location.	Similar to No Action Alternative, but the likelihood of closure due to catastrophic fire events decreases in the long- term with increased fire use and prescribed fire.	Alternative 2 minimizes effects to local businesses in the short term. However, it carries potential for moderate, adverse impacts in the future as suppression continues to allow fuels to build and the risk of high- intensity fire increases.

Table IV- 1. Summary Comparison of Impacts

Impact Area	Overview	No Action Alternative: 1995 FMP	Alternative 1 (Preferred): Full Toolbox	Alternative 2: Limited Prescribed Fire
Issue 4 (Cultural Resources): Unknown or unprotected historic structures and artifacts may incur damage directly from fire or from suppression activities.	Thinning, prescribed burning, and wildland fire use will reduce fuel buildup near structures and sites. Appropriate management response (suppression) will be dictated for the most sensitive areas within the park.	Potential for minor adverse impact by allowing fires to burn over most of the park. Some adverse suppression impacts are likely. Cultural resources benefit over the long- term from reduction of fuel loads in and around sites.	Similar to No Action Alternative, but less potential for disturbance because of suppression actions. The likelihood of harmful fires decreases in the long term as park- wide resource management objectives for fuel reduction are met.	Moderate adverse impacts are expected. Ground- disturbing suppression activities likely have greater effects under this alternative.
Issue 5 (Changes in Landscape- Scale Vegetation Patterns): Fire may change the landscape, altering ecosystem functioning and the present "look" of the park.	Plant communities are adapted to naturally occurring wildfire that helps remove fuel buildup. Some vegetation naturally experiences infrequent stand- replacing fires. Prescribed burning provides more control over fire intensity and effects.	Possible minor short- term adverse impacts; also minor to moderate long- term benefits. Criteria permitting prescribed and wildland fire use maintain or enhance park resources and reduce fuels. Catastrophic fire threat is lessened in the long- term as resource objectives for fuel reduction are met.	Alternative 1 is similar to No Action Alternative, but with greater potential for moderate long- term benefits.	Moderate, adverse long- term effects are likely. Suppression of wildland fire minimizes adverse effects to park aesthetics in the short- term but prevents natural processes from maintaining landscapes and increasing the potential for catastrophic fire in the future. More fuels will accrue under this alternative.
Issue 6 (Wildlife Habitat Change): Fire has the potential to harm or change wildlife habitat, causing some species to decrease in abundance and others to become more abundant.	Prescribed burning and wildland fire use allow for more control over fire. Low- to moderate- intensity fire thins crowded stands, maintains habitat mosaics, and reduces fuel loading that can contribute to catastrophic wildland fire.	Short- term minor adverse impacts are expected for some species, short- term minor beneficial impacts for others. Overall there should be minor to moderate long- term benefits as natural habitats are restored. Current knowledge and capability can minimize adverse effects while allowing wildland fires for resource benefit to occur. Increased wildland fire use for resource benefit would affect plants and animals intolerant of fire, but would benefit the ecosystem in the long- term.	Similar to the No Action Alternative. However, this alternative offers the greatest likelihood of long- term benefits as fuel loads are reduced and natural wildland fire is restored.	Long- term effects are probably moderately adverse. Applies the most suppression and mechanical fuel reduction, minimizing fire's short- term adverse impacts, but also minimizing long- term beneficial effects to wildlife.

Table IV- 1. Summary Comparison of Impacts

Impact Area	Overview	No Action Alternative: 1995 FMP	Alternative 1 (Preferred): Full Toolbox	Alternative 2: Limited Prescribed Fire
Issue 7 (Special- Status Species): Fire management activities may affect threatened, endangered, or sensitive species.	Low- intensity prescribed fires and wildland fire use can be conducted to minimize damage, but some adverse impacts may be necessary in the short term to achieve long- term benefits from fire-renewed habitats and fuel reduction.	Long- term effects are minor and beneficial; short- term effects are minor or moderately adverse. Wildland fire use and prescribed fire may directly and adversely affect individual plants and animals, but they can benefit sensitive species in the long- term. All practical mitigation and minimization actions are undertaken to reduce impacts.	Similar to No Action Alternative. Increased wildland fire use for resource benefit would best reduce the potential for catastrophic wildland fires, benefiting many species in the long term.	Long- term effects are moderately adverse; short- term effects are minor and adverse. Maximum suppression will minimize death and injury to plants and animals in the short term, but increase the potential for fuel buildups that cause high- severity fires in the long-term.
Issue 8 (Exotic Species): Prescribed and wildland fire, mechanical fuel reduction, and suppression activities may promote certain exotic species that invade disturbed areas.	Fires and suppression activities both create disturbances that may promote spread of exotic plants. Research programs can increase our understanding of fire effects on exotic species. Mitigation measures are important for all alternatives.	Minor short- term adverse impacts are expected. The potential for exotic plant spread exists both from allowing fires to burn, which clears areas for colonization, and from ground disturbances during suppression actions.	Similar to No Action Alternative. Alternative 1 may see less suppression and more wildland fire use, thus increasing the potential habitat for some exotic plants but reducing chances of their being spread by humans.	Minor short- term adverse impacts are expected. Suppression of all ignitions and little prescribed burning. Suppression disturbances potentially prepare more areas for colonization by exotics in the short term; large- scale, high- intensity fires potentially prepare areas in the long term.

Chapter V: Consultation and Coordination

The preparation of this EA involved interaction among many parties. Members of the IDT included Richard Gatewood, Chuck Barat, Timothy Stubbs, Renée West, Diane Dobos- Bubno, and Brooke Gebow. These individuals met frequently between June 2002 and Spring 2004.

Scoping, Consultation, and Review

The chronology below reviews scoping, outside consultation, and other milestones in support of this project. Chapter 1 provides a more detailed narrative of the process.

6- 5- 02 & 6- 6- 02	Internal scoping meeting, Carlsbad Caverns National Park, to produce preliminary goals and objectives, alternatives, and list of issues/impact topics	Attended by preparers (see below) and former superintendent Mick Holm, former biologist Diane Dobos- Bubno, former wildlife biologist Myra Barnes, chief ranger Mark Maciha, US Geological Survey (USGS) research ecologist William Halvorson, fire program assistant Kendra Mayes, Santiago Gonzales (USFWS), Jan Biella and Elizabeth Oster (New Mexico SHPO)
11- 7- 02	Public scoping newsletter mailed to combined Carlsbad Caverns and Guadalupe Mountains national parks mailing list	
11- 18- 02 through 11- 21- 02	Joint public scoping meetings with Guadalupe Mountains National Park on FMPs for both parks in El Paso (TX), Dell City (TX), Queen (NM), and Carlsbad (NM)	Staffed by IDT members from both parks
1- 22- 03	Continuation of internal scoping to draft preliminary impacts of alternatives	Attended by preparers plus Myra Barnes, Susan Moodie (University of Arizona), and former park fire effects monitor Dan Swanson
3- 7- 03	Continuation of internal scoping to draft preliminary fire treatment zones	Chuck Barat, Richard Gatewood, Brooke Gebow, Ethan Stapp
4- 10- 03	Scoping of BA	Chuck Barat, Diane Dobos- Bubno, Richard Gatewood, Brooke Gebow, David Roemer, Renée West
11- 12- 03	Submittal of Cultural Resources Component to New Mexico SHPO	Drafted by David Kayser
11- 19- 03	Submittal of BA to USFWS New Mexico Ecological Services Office	Formal consultation underway; biological opinion expected in early 2005.
2- 23- 04	Consultation initiated with New Mexico Department of Game and Fish	
3- 15- 04	Approval of Cultural Resources Component by New Mexico SHPO	
4- 04	Peer reviews received for internal draft EA	Ellis Richard, NPS (retired), and USFWS New Mexico Ecological Services Office

Preparers

Chuck Barat, *Deputy Superintendent, Carlsbad Caverns National Park* (*Chief, Division of Resources Stewardship and Science* during preparation of draft EA)—BS in Forestry and Park Management, Virginia Polytechnic Institute and State University; 25- year career with NPS includes 10 years as chief of resources at Lava Beds National Monument and Carlsbad Caverns National Park, 5 years as resource management specialist at Petersburg National Battlefield, 3 years as resource management ranger at Delaware Water Gap National Recreation Area, 5 years as resource management ranger at Cape Hatteras National Seashore, and 20 years as red- carded firefighter. Overall responsibility for the FMP and compliance process.

James Feldmann, *Planning Specialist, University of Arizona, School of Natural Resources*—expected MS in Planning from University of Arizona, BA in Business from University of Notre Dame. Served as document manager and editor after Ethan Stapp.

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Dale L. Pate, *Supervisory Physical Scientist (Cave Resources Specialist), Carlsbad Caverns National Park*—34 years experience in cave and karst field. Served as a hydrologic technician with the USGS in the Austin- San Antonio, Texas area for 15 years. Became the park cave specialist in July 1991. Assisted with background descriptions and analysis of resources.

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Timothy C. Stubbs *(now retired NPS)*—BS in Botany from San Diego State University, 24 years with NPS; FMO for both Carlsbad Caverns and Guadalupe Mountains National Parks 1990 to March 2003. He also worked at Great Smoky Mountains and Sequoia national parks where he began his career as a seasonal employee in 1969. Responsible for descriptions of fire operations.

Renée West, *Supervisory Biologist, Carlsbad Caverns National Park*—BA in cultural anthropology and MS in plant ecology from Arizona State University. Has worked 17 years in NPS and USFS, including 7 at CCNP. Responsible for vegetation sections and review of entire document.

List of Recipients

The recipients of the EA include: federal agencies, Indian tribes, state and local agencies, organizations, and individuals. The list is available upon request.

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Appendix A: Glossary

Term	Abbrev.	Description
Adverse Effect		A change that moves the resource away from a desired condition or detracts from its appearance or condition
Allelopathic		Direct influence from a chemical released from one living plant on development and growth of another
Beneficial Effect		A positive change in the condition or appearance of the resource or a change that moves the resource toward a desired condition
Biological Assessment	BA	An assessment presented to US Fish and Wildlife Service of effects on federally listed species, proposed listed species, or critical habitats of proposed federal actions that are not major construction projects (in this particular case, implementing a new fire management plan is the proposed action)
Biological Opinion	BO	The opinion of the US Fish and Wildlife Service on whether or not a proposed federal action is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat
Bureau of Land Management	BLM	US Department of Interior agency
Context		In cultural resources, the geographical or temporal environment of a proposed action, such that a change in the action relative to space or time might alter impacts
Cultural Landscapes		Landscapes as affected by people through time— the definition of such captures overlapping occupancy by different groups of people
Cultural Resources		Valued aspects of a cultural system that might be tangible (districts, sites, structures, objects)
Cultural Resources Component	CRC	Document analyzing effects of the proposed action on cultural resources for review by the State Historic Preservation Office (contained in Appendix C)
Cumulative Effects		Effects of actions (those in the past, present, or reasonably foreseeable future) that have an additive impact on the resources affected by the proposed action
Direct Effect		An impact that occurs as a result of the proposed action or alternative in the same place and at the same time as the action
Duration		The length of time of effects of an action
Exotic Species		Species not native to a particular ecosystem
Fire Management Plan	FMP	The plan that guides all fire- related activities at a park that is consistent with land and resource management plans and follows National Park Service guidelines
Fire Management Unit	FMU	A delineated area of the park that permits particular fire management strategies
Fuel		Vegetation, both living and dead, capable of burning

Term	Abbrev.	Description
Impairment		Impacts on resources that negatively, significantly, and possibly irreversibly alter their character from the state that made them important to protect in a park
Indirect Effect		An impact that occurs as a result of the proposed action, but removed in time and space from the action
Intensity		Magnitude of effect, from low to high
Lincoln National Forest	LNF	US Department of Agriculture Forest Service jurisdiction in southeastern New Mexico
Mechanical Treatment		Removal of vegetation by mechanical means (rather than by fire)
Minimum Requirement		The lowest impact means of accomplishing a task, frequently considered with respect to wilderness
Mitigation		Modification of an action that lessens the intensity of its impacts to a particular resource
National Historic Preservation Act	NHPA	The 1966 law that guides preservation of historic properties
National Environmental Policy Act	NEPA	The 1969 law that dictates the objective analysis and public scrutiny of the environmental, as well as social and economic, impacts of proposed federal actions and their alternatives prior to implementation
Natural Resources		Features of the natural environment, both physical (rock, water, air) and biological (plants, animals, bacteria)
No Action		Under the National Environmental Policy Act, No Action continues the current planning and operational direction and provides a baseline against which other alternatives can be measured
Non- fire Treatments		Removal of vegetation without using fire, most commonly through mechanical treatments
Non- indigenous Species		Species not native to a particular ecosystem (also called exotic species)
Prescribed Fire		Fire ignited by management to meet specific objectives
Prescription		Measurable environmental criteria, particularly temperature, relative humidity, wind speed and direction, and fuel moisture, that define the conditions under which a prescribed fire would be ignited, guide selection of appropriate management responses, and indicate other required actions. Safety, economic, public health, geographic, administrative, social, or legal considerations also affect decision- making
Scoping		Compilation of knowledge and opinions in order to properly develop and decide on alternative courses of action, both internally to the park and externally with the public

Term	Abbrev.	Description
Sensitive Species		Species sensitive to perturbation from the proposed action, frequently rare species that are federal or state-listed, proposed for listing, occurring in very few places, or particularly sensitive to the action's impacts
Species Diversity		A measure of the number of species in an area (species richness) that also accounts for species abundance
State Historic Preservation Office	SHPO	The state office overseeing protection of cultural resources
Succession		The natural evolution of biotic communities over time following disturbance
Suppression		All the work of extinguishing a fire beginning with its discovery, using confine, contain and control actions
Thinning		Reduction of vegetation density, frequently using non- fire (or mechanical) means
Timing		How effects vary depending on when the action takes place
US Fish and Wildlife Service	USFWS	US Department of Interior agency charged with overseeing protection of endangered and threatened species
Unique Sites		Sites sufficiently uncommon such that their presence is a special feature of the park with intrinsic value and of interest to visitors
Unique Stands		Patches of vegetation that are uncommon in an area that may be relicts from an earlier age
USDA Forest Service	USFS	US Department of Agriculture agency overseeing national forests
Watershed		Land above a given point in a drainage that contributes water to the streamflow of that drainage
Wilderness		Congressionally designated area managed to perpetuate natural processes and minimize human impacts
Wildland Fire Use		Naturally (lightning) ignited fire managed to meet resource benefits

Appendix B: Common and Scientific Names

African rue (*Peganum harmala*)
ailanthus, tree of heaven (*Ailanthus altissima*)
alligator juniper (*Juniperus deppeana*)
American kestrel *(Falco sparverius)*
Apache plume (*Fallugia paradoxa*)
arid land ribbon snake (*Thamnophis proximus diabolicus*)
badger (*Taxidea taxus*)
Baird's sparrow (*Ammodramus bairdii*)
banner- tailed kangaroo rat *(Dipodomys spectabilis)*
Barbary sheep *(Ammotragus lervia)*
Bell's vireo (*Vireo bellii*)
big brown bat (*Eptesicus fuscus*)
big free- tailed bat (*Nyctinomops macrotis*)
bigtooth maple (*Acer grandidentata*)
black grama (*Bouteloua eriopoda*)
black walnut (*Juglans nigra*)
blue grama (*Bouteloua gracilis*)
blotched water snake (*Nerodia erythrogaster transversa*)
brown- headed cowbird (*Molothrus ater*)
bullfrog (*Rana catesbeiana*)
bullgrass (*Muhlenbergia emersleyi*)
burrowing owl *(Athene cunicularia)*
California myotis (*Myotis californicus*)
cardinal penstemon (*Penstemon cardinalis* ssp. *regalis*)
catclaw mimosa (*Mimosa biuncifera*)
cave myotis (*Myotis velifer*)
cave swallow (*Hirundo fulva*)
Chaplin's golden columbine (*Aquilegia chrysantha* var. *chaplinei*)
cloak fern (*Notholaena* species)
Cooper's hawk *(Accipiter cooperii)*
coyote (*Canis latrans*)
creosotebush (*Larrea tridentata*)
curlyleaf muhly (*Muhlenbergia setifolia*)
dalea (*Dalea* species)
desert ceanothus (*Ceanothus greggii*)
desert bighorn sheep (*Ovis canadensis*)
desert willow (*Chilopsis linearis*)
eastern pipistrelle (*Pipistrellus subflavus*)
eastern red bat (*Lasiurus borealis*)
five- flowered rockdaisy (*Perityle quinqueflora*)
feral goats (*Capra* species)

field bindweed (*Convolvulus arvensis*)
fringed myotis (*Myotis thysanodes*)
gray fox (*Urocyon cinereoargenteus*)
gray oak (*Quercus grisea*)
gray sibara (*Sibara grisea*)
gray vireo (*Vireo vicinior*)
gray wolf (*Canis lupus*)
gray- banded kingsnake (*Lampropeltis alterna*)
great sage (*Salvia summa*)
greenthroat darter (*Etheostoma lepidum*)
Guadalupe mescal bean (*Sophora gypsophila* var. *guadalupensis*)
Guadalupe milkwort (*Polygala rimulicola* var. *rimulicola*)
Guadalupe pincushion (*Escobaria guadalupensis*)
Guadalupe rabbitbrush (*Chrysothamnus nauseosus* ssp. *texensis*)
Guadalupe valerian (*Valeriana texana*)
hairy grama (*Bouteloua hirsuta*)
hairy tridens (*Erioneuron pilosum*)
hoary bat (*Lasiurus cinereus*)
javelina, peccary (*Tayassu tajacu*)
Johnson grass (*Sorghum halepense*)
Klein grass (*Panicum coloratum*)
lechuguilla *(Agave lechuguilla)*
Lee pincushion cactus (*Coryphantha sneedii* var. *leei*)
Lehmann lovegrass (*Eragrostis lehmanniana*)
little walnut (*Juglans microcarpa*)
littleleaf sumac (*Rhus microphylla*)
long- legged myotis (*Myotis volans*)
Malta starthistle (*Centaurea melitensis*)
mariola (*Parthenium incanum*)
mat leastdaisy (*Chaetopappa hersheyi*)
McKittrick pennyroyal (*Hedeoma apiculata*)
Merriam's elk (*Cervus elaphus merriamii*)
mescal (*Agave* species)
mescal bean (*Sophora secundiflora*)
Mexican free- tailed bat (*Tadarida brasiliensis mexicana*)
Mexican spotted owl (*Strix occidentalis lucida*)
Mormon tea (*Ephedra* species)
mottled rock rattlesnake (*Crotalus lepidus lepidus*)
mountain lion (*Puma concolor*)
mountain mahogany (*Cercocarpus montanus*)
mouse (species in the family Muridae)
muhly grass (*Muhlenbergia* sp.)
mule deer (*Odocoileus hemionus*)

northern goshawk (*Accipiter gentilis*)
northern harrier *(Circus cyaneus)*
ocotillo (*Fouquieria splendens*)
pallid bat (*Antrozous pallidus*)
peregrine falcon (*Falco peregrinus anatum*)
piñon, pinyon (*Pinus edulis*)
pocketed free- tailed bat (*Nyctinomops femorosaccus*)
ponderosa pine (*Pinus ponderosa*)
porcupine (*Erethizon dorsatum*)
prairie dog (*Cynomys ludovicianus*)
prickly pear (*Opuntia phaeacantha* and other *Opuntia* species)
puncturevine, goathead (*Tribulus terrestris*)
rabbit (species in the family Leporidae)
raccoon (*Procyon lotor*)
redberry juniper, Pinchot juniper (*Juniperus pinchotii*)
red- tailed hawk *(Buteo jamaicensis)*
ringtail (*Bassariscus astutus*)
Rio Grande cooter (*Pseudemys gorzugi*)
Rio Grande leopard frog (*Rana berlandieri*)
Russian- olive (*Elaeagnus angustifolia*)
Russian- thistle (*Salsola* species)
saltcedar, tamarisk (*Tamarix* species)
sandpaper oak (*Quercus pungens*)
scaled quail (*Callipepla squamata*)
Scheer pincushion cactus (*Coryphantha scheeri* var. *scheeri*)
Scotch thistle (*Onopordum acanthium*)
sharp- shinned hawk *(Accipiter striatus)*
shining coralroot (*Hexalectris nitida*)
Siberian, Chinese elm (*Ulmus pumila*)
side- oats grama (*Bouteloua curtipendula*)
silverhaired bat (*Lasionycteris noctivagans*)
skeletonleaf goldeneye (*Viguiera stenoloba*)
skunk (species in the family Mustelidae)
slim tridens (*Tridens muticus*)
small- footed myotis (*Myotis ciliolabrum*)
Sneed pincushion cactus (*Coryphantha sneedii* var. *sneedii*)
southwestern willow flycatcher (*Empidonax traillii extimus*)
sotol (*Dasylirion leiophyllum*)
sparseflower jewelflower (*Streptanthus sparsiflorus*)
squirrel (species in the family Sciuridae)
tarbush (*Flourensia cernua*)
Texas madrone (*Arbutus xalapensis*)
Texas sacahuista (*Nolina texana*)

Tharp's blue- star (*Amsonia tharpii*)
threeawn (*Aristida* sp.)
tobosa (*Hilaria mutica*)
turkey vulture *(Cathartes aura)*
varied bunting (*Passerina versicolor*)
wavyleaf oak (*Quercus undulata*)
weasel (*Mustela frenata*)
western big- eared bat (*Corynorhinus townsendii*)
western pipistrelle (*Pipistrellus hesperus*)
white horehound (*Marrubium vulgare*)
whitethorn acacia (*Acacia constricta*)
woolly mullein, common mullein (*Verbascum thapsus*)
Wright's justicia (*Justicia wrightii*)
yellow starthistle (*Centaurea solstitialis*)
yellow- billed cuckoo (*Coccyzus americanus*)
yellowseed nama (*Nama xylopodum*)

Appendix C: Cultural Resources Matrix

The cultural resources analysis presented here began with discussion at an internal scoping meeting of park resource management, fire, interpretive staff and University of Arizona cooperators in June 2002. Elizabeth Oster and Jan Biella of the New Mexico SHPO attended the meeting and offered their ideas about how the analysis should proceed. David Kayser (park archeologist, cultural resource specialist) led the cultural resources analysis efforts for this EA and the production of a CRC, a document summarizing concerns and solutions for submittal to the SHPO. David put together the matrix appearing here with help from Dan Swanson, fire effects monitor. They made substantial progress on the analysis while attending a class on cultural resources and fire at the NPS Western Archeological Conservation Center, in January 2003.

The CRC received comments and favorable review from a number of parties:

- Elizabeth Oster, staff archeologist, New Mexico SHPO, Santa Fe, New Mexico
- Jim Bradford and staff, NPS, Intermountain Region, Santa Fe, Support Office
- Jill Cowley, historical landscape architect, NPS, Intermountain Region, Santa Fe, Support Office
- Jan Biella, deputy historic preservation officer, New Mexico SHPO
- Virginia Salazar- Halfmoon, chief curator, NPS, Intermountain Region, Santa Fe, Support Office

This matrix (Tables C1- C5, pages 109- 112) considers historical, archeological, architectural, engineering and cultural values to define resources sensitive to fire program activities. It also specifies the particular aspects at risk, reviews what fire program activities create the risk, defines protection objectives for these resources, and suggests methods to minimize or mitigate impacts in order to achieve the objectives. The matrix is a working summary of resources and how the fire program should relate to cultural resources. It is a useful guide, both for fire and cultural resources planning and operations in the park.

Definitions of terms

Historic contexts are the historic and prehistoric themes under which various resources were created and used. Individual resources are best understood and evaluated by understanding the roles they played within specific historical framework s. In Table C- 1, the Euro- American Ranching- Mining Exploration- Early NPS context covers resources dating from the 1890s to 1950.

Resource types represent general function or morphology. The exact function may not be known, especially for prehistoric resources. In Table C- 1, historic districts are specific resource types that are the setting for a number of different elements.

Elements are the specific physical characteristics of resource types. Identifying the elements allows us to define specific elements or values at risk from various fire management activities. In Table C- 1, the IDT lists four specific elements under the historic districts resource type: feature integrity, district integrity, visual integrity, and water quality.

Risk conditions or activities are the specific environmental conditions and/or fire management activities that place particular resources at risk. In Table C- 1, plant loss/ground disturbance and water quality are listed as putting Rattlesnake Springs Historic District at risk.

Fire management objectives guide actions in a way that protects the elements or values at risk. Table C- 1 recommends reducing fuels and suppressing fires near historic structures.

Treatments or prescriptions are methods of attaining the objectives. In Table C- 1, pretreatment and line construction are necessary.

- Reduce fuels in and around sites and artifacts using mechanical fuel reduction and/or prescribed fire, as appropriate.
- Manage the movement of fire into an identified sensitive cultural resource area only while taking safety and natural resource protection into consideration.
- Under certain circumstances, wildland fires and prescribed burns will be prevented from entering sensitive cultural resource areas.
- At fire- vulnerable sites, such as corrals, other wooden structures or features and hearths on archeological sites, some form of documentation, sampling, or erecting protective barriers, etc can mitigate adverse effects prior to fires.
- Cultural resource inventories designed in conjunction with the New Mexico SHPO will be conducted in burn units prior to prescribed burn activities.

Currently, the park consults with the Mescalero Apache Tribe, Ysleta Del Sur Pueblo (Texas), Hopi Tribe, Pueblo of Isleta (New Mexico), Jicarilla Apache Nation, Pueblo of Zia, Pawnee Nation, Commanche Nation, Kiowa Indian Tribe, San Carlos Apache Tribe, White Mountain Apache Tribe, Zuni Tribe, Apache Tribe of Oklahoma, and the Fort Sill Apache Tribe. Relevant state and federal agencies, local governments, local businesses, non- government organizations, and private residents living adjacent to or near the park are also consulted.

For this FMP, the park sent the public scoping newsletters to a mailing list that includes the parties listed above. Four public scoping meetings took place in November 2002, and the public scoping comment period extended from November 15 until December 31, 2002. Letters were sent to the Mescalero Apache tribal president, the Ysleta del Sur Pueblo, the Hopi Tribe Office of the Chairman, and other groups in 2003 bringing them up to date on the planning progress at Carlsbad Caverns National Park.

Table C- 1. Historic Context: Euro- American Ranching- Mining Exploration- Early NPS (1890s to 1950).

Resource Type	Elements	Elements or Values at Risk	Risk Conditions or Activities	Fire Management Objectives	Treatments or Prescriptions
cultural and ethnographic landscapes	landscape arrangements	feature integrity and arrangement (fire also can maintain historic scene)	ground disturbance, loss of landscape features; erosion	minimize disturbance	pretreatment, line construction
historic districts	Carlsbad Caverns Historic District, roads/paths, structures, parking lots, bridges, plants, vegetation patterns	feature integrity, district integrity, visual integrity	plant loss and ground disturbance, loss/damage to structures/features and/or artifacts/deposits	reduce fuels, full suppression	pretreatment, line construction, use water where possible, use retardant where damage would be minimal, photo documentation
	Rattlesnake Springs Historic District	feature integrity, district integrity, visual integrity, water quality	plant loss and ground disturbance, water quality	reduce fuels, full suppression	pretreatment, line construction
	metal water tank and pipeline	not at risk			any suppression activities
ranches and mines	masonry foundations and other stone work	physical integrity	ground disturbance, increased erosion	minimize disturbance, suppression	pretreatment, line construction, use water where possible to suppress.
	windmills	wooden features	loss or damage	avoid disturbance	same as above
	fencing	metal wire	increased oxidation and rusting	minimize disturbance	collection, photo documentation
	fence posts/corrals, cabins and houses	wooden features	loss or damage	suppression	any suppression activity
	equipment, trash, single objects or dumps	wooden features, metal elements, glass, plastics, etc.	loss or damage, increased oxidation/rusting	minimize disturbance, suppression	pretreatment, line construction

Feature refers to an individual or group of elements, such as a hearth, midden, posthole, house, corral, floor, wall, rock art, etc. Generally, non- portable objects, in an archeological site not recoverable from its matrix. A prominent or distinctive aspect, quality or characteristic of a historic property or a historic property itself. **District:** a geographically definable area possessing a significant concentration, linkage, or continuity of sites, landscapes, structures, or objects united by past events or aesthetically by plan or physical developments. May refer to a designated cluster of features, such as the fieldstone ranger houses, other buildings, roads, paths, parking lots of an area. The Carlsbad Caverns Historic District is a good example. Integrity is the authenticity of a property's historic identity, evidenced by the survival of physical characteristics sufficient during its historic or prehistoric period; the extent to which a property retains its historic appearance. **Loss of physical integrities** may be loss from an individual feature, multiple features, or a whole district if destroyed or damaged.

Table C- 2. Historic Context: Euro- American Early- Anglo- Military- Homestead Period (1850 to 1900).

Resource Type	Elements	Elements or Values at Risk	Risk Conditions or Activities	Fire Management Objectives	Treatments or Prescriptions
camps and homesteads	camps (tent pads, hearths)	feature locale	damage, loss, increased erosion	minimize disturbance	pretreatment; all
	houses	foundations, feature locale, and remaining wooden features	damage, loss, increased erosion	divert fire from sites; suppression; minimize disturbance	pretreatment; all suppression activities; photo documentation
	dugouts	remaining depression	damage or loss, increased erosion	suppression; minimize disturbance	pretreatment; all suppression activities; photo documentation
	stone masonry	physical integrity	ground disturbance, increased erosion	avoid disturbance	any suppression activities
	metal, wood, glass, ceramic, paper, or plastic artifacts, trash dumps/middens	physical integrity, paper, plastic and wood lost, arrangement	ground disturbance, loss or damage, increased erosion	avoid disturbance	pretreatment
irrigation system	ponds, ditches, gates, flumes	physical integrity	ground disturbance, damage	minimize disturbance	any suppression activities
roads/trails	various vehicle roads and foot trails	feature integrity	ground disturbance, increased erosion	minimize disturbance	pretreatment, revegetation
historic record locales	military encampments	feature integrity and arrangement	ground disturbance, loss of landscape features, erosion, fire could help maintain cultural scene	minimize disturbance	pretreatment, revegetation
	US military- Indian engagement sites	feature integrity and arrangement (fire could also maintains historic scene)	ground disturbance, loss of landscape features, erosion, fire could help maintain cultural scene	minimize disturbance	pretreatment, revegetation
	homestead locales (includes ranch use locales)	physical integrity	ground disturbance, loss of landscape features, erosion, fire could help maintain cultural scene	minimize disturbance	pretreatment, revegetation

In some cases, fire may be beneficial to historic landscapes and archeological site preservation. Examples are the use of low intensity fires to remove brush from pasture or keeping ring middens free of brush and trees or maintaining certain landscape arrangements free of brush or invasive trees.

Table C- 3. Historic Context: Native American Late Prehistoric Period to European- American Contact (AD 750 to 1540- 1846).

Resource Type	Elements	Elements or Values at Risk	Risk Conditions or Activities	Fire Management Objectives	Treatments or Prescriptions
camps and villages	hearths	feature integrity, radiocarbon contamination	ground disturbance, carbon loading from fire, increased erosion	avoid disturbance, reduce fuels	pretreatment, avoid disturbance
	wickiup/tipi base rock outlines/ breastworks	feature integrity	ground disturbance, loss of concealment, increased erosion	avoid disturbance,	pretreatment, avoid disturbance
	lithics	feature integrity, physical change, security	ground disturbance, loss of concealment, increased erosion	avoid disturbance,	pretreatment, avoid disturbance
	ceramics	feature integrity, physical change, security	ground disturbance, loss of concealment, increased erosion	avoid disturbance, reduce fuels	pretreatment, avoid disturbance
	fire cracked rock middens (plant roasting features)	feature integrity and arrangement radiocarbon contamination	ground disturbance, increased erosion	avoid disturbance, reduce fuels	pretreatment, avoid disturbance
	rock shelters	physical integrity, increased erosion	ground disturbance, rock flaking from heat	avoid disturbance, reduce fuels, suppression	pretreatment, line construction, avoid disturbance
	rock art	feature integrity, pigments, security, tribal cultural identity, interpretive value	ground disturbance, loss of concealment, UV exposure, increased erosion, heat flaking, retardant drop, smoke damage	suppression	line construction, avoid disturbance
cultural landscapes	sacred sites	tribal cultural integrity, interpretive value	ground disturbance, loss of key features	suppression, avoid disturbance	pretreatment, line construction
	landscape arrangements	feature integrity and arrangement (fire could maintain setting)	ground disturbance, loss of key features in fire, erosion	avoid disturbance, reduce fuels	pretreatment, revegetation
	springs	integrity (fire could maintain setting)	loss or damage	avoid disturbance, reduce fuels	pretreatment, revegetation
	agave fields/ groups/clusters	individual plants, traditional food	plant mortality, loss or damage	reduce fuels	pretreatment, timing of prescribed burn

In some cases, fire may be beneficial to historic landscapes and archeological site preservation. Examples are the use of low intensity fires to remove brush from pasture or keeping ring middens free of brush and trees or maintaining certain landscape arrangements free of brush or invasive trees.

Table C- 4. Historic Context: Native American Early Prehistoric Period (Paleo- Indian and Archaic Periods) through AD 750.

Resource Type	Elements	Elements or Values at Risk	Risk Conditions or Activities	Fire Management Objectives	Treatments or Prescriptions
Camps, habitations, and activity areas.	hearths	feature integrity, radiocarbon contamination	ground disturbance, carbon loading from fire, increased erosion	avoid disturbance, reduce fuels	pretreatment, line construction, use water to suppress, use retardant where damage would be minimal, photo documentation
	fire cracked rock middens (plant roasting features)	feature integrity and arrangement, radiocarbon contamination	ground disturbance, carbon loading from fire increased erosion	avoid disturbance, reduce fuels	same as above
	lithics	physical integrity, associated radiocarbon contamination, spatial arrangement	ground disturbance, loss of concealment, increased erosion	avoid disturbance, reduce fuels	pretreatment, avoid line construction
	rock shelters, and caves	physical integrity, increased erosion	ground disturbance, rock flaking from heat, increased erosion	avoid disturbance, reduce fuels, suppression	pretreatment, use line construction
	rock art	feature integrity, pigments, security, tribal cultural identity, interpretive value	ground disturbance loss of concealment, UV exposure, increased erosion, flaking from heat, retardant drop, smoke damage	suppression	pretreatment, use line construction
	bedrock mortar holes	feature integrity	ground disturbance	avoid disturbance	any suppression activities

Table C- 5. Paleontological Resources.

Resource Type	Elements	Elements or Values at Risk	Risk Conditions or Activities	Fire Management Objectives	Treatments or Prescriptions
cave sites	deposits within or near mouths of caves	feature integrity, radiocarbon contamination	ground disturbance, carbon loading from fire, increased erosion	avoid disturbance, reduce fuels	pretreatment, line construction, use water where possible to suppress, use retardant where damage would be minimal, photo documentation
open sites	fossils or deposits	feature integrity and arrangement, radiocarbon contamination	ground disturbance, carbon loading from fire increased erosion	avoid disturbance, reduce fuels	same as above

Appendix D: Issues Related to Fire Management Planning

Possible Impact Area	Issues, Concerns, Opportunities
Geological Resources	
paleontological specimens	▪ Heat from fire may cause exfoliation of rock surfaces and expose fossils. ▪ Fire may char specimens. ▪ Fuel reduction can prevent high- intensity fire in areas of known paleontological resources. ▪ Damage to fossils has not been a problem over 60 years of recorded fires (approximately 300 events).
soils	▪ Fire may expose soil and increase erosion. ▪ Hot fires can sterilize soil. ▪ Line construction can lead to erosion. ▪ Suppression limits fire- influenced nutrient recycling.
caves	▪ Burning of vegetation may reveal cave entrances. ▪ The effects of fire on karst system hydrology are unknown. ▪ Park caves appear unaffected by 60 years of recorded fires.
rocks	▪ Heat may cause cracking of rocks.
Geohazards	
sediment load	▪ The potential for debris and mudflows increases when intense storms hit fire- denuded slopes. ▪ Rocky, broken up landscape prevents fires from burning large, contiguous areas that would generate large quantities of sediment.
flooding	▪ Potential exists for heightened peak flood levels after fires. ▪ Past post- fire peaks have not caused problems.
Soundscapes	
aircraft operations	▪ Aircraft used in fire management activities cause noise and visual disturbances in all areas of the park, including designated wilderness. ▪ Most park visitors come to see caves; very few spend substantial time exploring the surface and backcountry areas where aircraft might be a disturbance. ▪ Wildland fire events generally end quickly due either to small size or rapid, wind- driven movement.
Water	
quantity	▪ Spring flows may increase over the short term following fire due to the clearing of overgrown vegetation.

Possible Impact Area	Issues, Concerns, Opportunities
quality	▪ Runoff from fire- denuded slopes will contain increased particulate load. ▪ Rocky, broken up landscape prevents fires from burning large, contiguous areas that would generate large quantities of sediment.
Air Quality	
smoke	▪ Smoke may be a health hazard or regulatory problem during fires. ▪ Smoke may degrade air quality inside caves, but has not caused problems over the history of the park.
Wetlands	
hydrology	▪ See *Geohazards* and *Water*.
vegetation	▪ Fire will thin overgrown stands. ▪ Exclusion of fire and buildup of fuels makes habitat alteration due to intense fire more likely.
wildlife	▪ Short- term changes in water quality as a result of fire may impact aquatic species.
Land Use	
property damage	▪ Fire is a threat to park developments, structures and landscaping. ▪ Escaped fires may cause damage to private property, including gas and oil developments on neighboring lands. ▪ Wildland fire use, prescribed burning and thinning can reduce the risk of property loss from fire in the long term.
neighbors	▪ Fire may burn across boundary to neighboring private, BLM, or USFS property, or from neighboring property onto the park. ▪ The Sloan inholding is a concern for fire operations. ▪ Ranchers are concerned about park fires spreading onto their property and burning grazing land. ▪ Neighbors may benefit from fire's vegetation- renewing and habitat-enhancing effects.
Vegetation	
rare or unusual vegetation	▪ Fires of high intensity may damage or eliminate *unique stands* of vegetation, such as oak woodlands, Texas madrone, bigtooth maple groves, riparian communities, and cave entrance communities. ▪ Rocky, broken up landscape promotes burn mosaics less likely to eliminate unique stands of vegetation. ▪ Low intensity fire can promote germination or enhance habitat for uncommon species.

Possible Impact Area	Issues, Concerns, Opportunities
Species of Special Concern	
plants	▪ Effects of fire on numerous endemics and sensitive species are not well known. ▪ Listed, endemic, and sensitive species may experience death, injury, or destruction of habitat.
animals	▪ Rare or protected species might suffer injury, death, or destruction of habitat by fire. ▪ Smoke and soot may pose a short- term threat to bats. ▪ Effects of fire on sensitive species are not well known; species may benefit from fire- induced habitat renewal.
Unique Sites	
World Heritage Site	▪ Carlsbad Caverns is listed as a World Heritage Site for the geologic significance of the caves. ▪ Fire is not likely to affect the features that make the park recognized worldwide.
unique natural features	▪ Fire may alter the existing visual values and endemic or unique vegetation at Rattlesnake Springs and Slaughter Canyon. ▪ Pockets of endemic plants may have difficulty regenerating after intense fires. ▪ Wildland fire use, prescribed burning and thinning can reduce fuels and risk of loss of unique features.
Important Wildlife Considerations	
popular species	▪ Bats that roost in the park, including the Mexican free- tailed bat, are critical to the park's popular identity. ▪ Smoke and soot may pose a threat to bats but have not been a problem over the history of the park. ▪ Fire effects on habitat may favor certain species while deterring others. ▪ Fire can kill and injure wildlife species (bird nests are especially susceptible).
invertebrates	▪ Invertebrates have not been inventoried at the park, and fire effects are unknown.
Fish	
rare species	▪ The greenthroat darter at Rattlesnake Springs could be at risk from negative impacts to water quality and quantity. ▪ Mechanical fuel reduction would precede any prescribed fire activities at Rattlesnake Springs.

Possible Impact Area	Issues, Concerns, Opportunities
Non- Native Species	
invasive species	▪ Fire effects on most invasive species are unknown. ▪ Fire may facilitate the spread of certain non- native plants, particularly those that invade disturbed areas. ▪ Fire may aid in the control of species that are susceptible to fire, or promote native species over non- native. ▪ Fire can be used to reduce biomass of invasive plants in combination with other treatments to eliminate them.
Visitor Experience	
education	▪ Fires provide an opportunity for park staff to educate visitors and themselves regarding the role of fire in the park.
recreation opportunities	▪ Fire may necessitate temporary closures of trails. ▪ Fire in certain locations may force park closure. ▪ The vast majority of visitors come for cave experiences and would be little affected by aboveground closures. ▪ Wildland fire use, prescribed burning and thinning can reduce fuels and likelihood of future fires interfering with recreation.
Cultural Resources	
archeological sites	▪ The types of archeological resources in the park have been identified, but specific sites are largely unknown. ▪ Prescribed fire and manual thinning can reduce fuels around sensitive sites. ▪ Effects of suppression activities generally are more serious than effects of fire.
structures	▪ Fire might damage or destroy fire- susceptible structures listed on the National Register of Historic Places. ▪ Prescribed fire and manual thinning can reduce fuels around sensitive sites. ▪ Effects of suppression activities generally are more serious than effects of fire.
sacred sites	▪ Sacred sites may be damaged or altered from their original arrangement. ▪ Prescribed fire and manual thinning can reduce fuels around sensitive sites. ▪ Effects of suppression activities generally are more serious than effects of fire.

Possible Impact Area	Issues, Concerns, Opportunities
Socioeconomics	
local businesses	▪ Public access restrictions or closure may impact concessions in the park. ▪ Minor benefits accrue to community lodging and catering businesses during fire activities with an influx of fire- fighting crews. ▪ Whites City and Carlsbad businesses would potentially lose income during long- term closure or access restrictions. ▪ Wildland fire events generally end quickly due either to small size or rapid, wind- driven movement.
Energy Resources	
oil and gas development	▪ BLM is concerned with fires crossing the north boundary and threatening oil and gas drilling operations and pipelines. ▪ Grazing keeps fuels sparse on BLM lands across the north boundary.
Other Agency Policies	
federal agencies	▪ Park and other agency fire policies may not be compatible. ▪ Coordination with USFS and BLM is needed to manage fire appropriately near park boundaries. ▪ Coordination is needed with USFWS on special- status species.
Urban Quality	
gateway communities	▪ Whites City and Carlsbad are linked socially and economically with the park, and large fires could cause short- term effects in these communities. ▪ At the extreme, closure of the park would adversely impact tourism-related businesses in these communities. ▪ No fire- related closures have ever occurred at Carlsbad Caverns.
Wilderness	
designated	▪ Approval of mechanized tool use in wilderness would bring noise and visual disturbances. ▪ Very few visitors use the above- ground wilderness areas at Carlsbad Caverns. ▪ Disturbance to wilderness and disruption of wilderness experience have not been problems over 60 years of recorded fires (approximately 300 events), including 35 prescribed burns.
potential	▪ The 320- acre Sloan inholding is identified as potential wilderness.
Other	
night sky	▪ Smoke, light from fire, and nighttime firefighting efforts will affect the night sky. ▪ Fire events are very short in duration.

Appendix E: Comparison of Alternatives' Effectiveness in Meeting Park Fire Management Goals and Objectives

	No Action Alternative: Continue Current Direction	Alternative 1 (Preferred): Full Toolbox	Alternative 2: Limited Prescribed Fire
Major Features	The park backcountry falls in FMU 1, where wildland fire use is permitted. Non- fire fuel treatment will be applied around developed areas and sensitive resources. The conditional suppression zone, FMU 2, follows the perimeter of the park and allows wildland fire use and prescribed fire under a narrower range of conditions than FMU 1. FMU 3 is a suppression zone containing sensitive resources and structures, allowing prescribed fire for fuel reduction, but no wildland fire use.	A small FMU 1 encompasses developments and an area of the park next to Whites City where ignitions are suppressed, but prescribed burns for fuel reduction can take place. FMU 2 allows prescribed fire and wildland fire use in the backcountry out to park boundaries. Decision criteria for wildland fire use are flexible. The park would cooperate with park neighbors on fire management actions. Non- fire fuel treatment will be applied around developed areas and sensitive resources.	Single suppression FMU contains the entire park. Limited prescribed fire is allowed only under conditions minimizing fire escape. No wildland fire use. Non- fire fuel treatment will be applied around developed areas, sensitive resources, and possibly boundary areas.
Goals and Objectives			
1. Protect people and property as the highest priority of every fire management activity.	Effective with actions required to reduce threats to life and property.	Most effective in the long run as hazardous fuel loads are reduced and areas upwind of the park are cooperatively treated.	Effective in the short run with high level of suppression; effectiveness diminishes in the long run as fuels build up.
2. Protect the park's natural and cultural resources from undesirable effects of fire and suppression.	Effective in the short and long term.	Effective in both the short and long term. It allows for the greatest adaptability in management response to changing conditions and maximizes fire on the landscape, which decreases the likelihood of high- severity fires.	Most effective at protecting resources from direct effects of fire in the short term with its high level of suppression. It also brings more suppression impacts and is ultimately least effective in the long term because it allows fuels to continue to build up.
3. Suppress unwanted fire.	Effective	Effective	Effective
4. Maintain or restore fire as a natural dynamic ecosystem process.	Effective because it permits wildland fire use for much of the park.	Most effective because it permits wildland fire use over the greatest area of the park.	Least effective at restoring fire. A suppression response is dictated for all natural ignitions, and only a limited

	No Action Alternative: Continue Current Direction	Alternative 1 (Preferred): Full Toolbox	Alternative 2: Limited Prescribed Fire
			amount of prescribed fire is envisioned.
5. Apply wildland fire use and prescribed fire for resource management purposes.	Allows fire over most of the area up to park boundaries for management purposes.	Most effective at duplicating fire's landscape effects, recreating historic scenes, and promoting natural patterns of succession.	Applies the least fire for resource management purposes.
6. Facilitate joint planning and implementation of fire operations with neighboring agencies and private landowners.	Moderately effective.	Encourages the most cooperation with neighboring agencies and private landowners.	Insulates surrounding lands by keeping fire on park lands and limiting prescribed fire. Does not accomplish goal.
7. Coordinate fire activities with all park divisions and the public.	Effective	Effective	Effective

Appendix F: Exotic Plants at Carlsbad Caverns National Park

This checklist was compiled by Renée West, June 2002.

Trees

Tamaricaeae		
	Tamarix sp.	saltcedar
Elaeagnaceae		
	Elaeagnus angustifolia	Russian olive
Salicaceae		
	Populus nigra var. *italica*	Lombardy poplar
	Salix babylonica	weeping willow
Simaroubaceae		
	Ailanthus altissima	ailanthus or tree of heaven
Rosaceae		
	Malus domestica	apple
	Prunus armeniaca	apricot
	Prunus domestica	plum
Ulmaceae		
	Ulmus pumila	Siberian or Chinese elm
Moraceae		
	Morus sp.	mulberry

Grasses and Forbs

Poaceae		
	Sorghum halepense	Johnson grass
	Eragrostis lehmanniana	Lehmann lovegrass
	Panicum coloratum	Klein grass
	Cynodon dactylon	Bermuda grass
	Digitaria sanguinalis	crabgrass
	Avena fatua	wild oat
	Bromus catharticus	rescuegrass
	Bromus japonicus	Japanese brome
	Echinochloa crus- galli	barnyardgrass
	Eleusine indica	goosegrass
	Eragrostis cilianensis	stinkgrass
	Hordeum hystrix	Mediterranean barley
	Poa annua	annual bluegrass
	Polypogon monspeliensis	rabbitfoot grass
Chenopodiaceae		
	Salsola sp.	Russian thistle
	Kochia scoparia	summer- cypress (kochia)
Asteraceae		
	Centaurea melitensis	malta starthistle

	Sonchus sp.	sowthistle (various)
	Taraxacum officinale	dandelion
	Lactuca sp.	prickly lettuce
	Centaurea solstitialis	yellow starthistle*
	Onopordum acanthium	Scotch thistle*
Convulvulaceae		
	Convolvulus arvensis	field bindweed
Scrophulariaceae		
	Verbascum thapsus	woolly mullein
Lamiaceae		
	Marrubium vulgare	white horehound
	Lamium amplexicaule	common dead nettle
	Mentha spicata	spearmint
Zygophyllaceae		
	Tribulus terrestris	puncturevine (goathead)
	Peganum harmala	African rue*
Portulacaceae		
	Portulaca oleracea	common purslane
Liliaceae		
	Asparagus officinalis	garden asparagus
Verbenaceae		
	Verbena hastata	blue vervain
Geraniaceae		
	Erodium cicutarium	filaree (crane's bill)
Euphorbiaceae		
	Euphorbia sp.	spurge
Fabaceae		
	Medicago lupulina	black medic
	Melilotus alba	white sweetclover
	Melilotus officinalis	yellow sweetclover
Oxalidaceae		
	Oxalis corniculata	woodsorrel
Brassicaceae		
	Sisymbrium altissimum	tumble mustard
	Sisymbrium irio	London rocket
	Nasturtium officinale	watercress
	Descurainia sophia	flixweed
	Thlaspi arvense	field pennycress
Plantaginaceae		
	Plantago lanceolata	buckhorn plantain
	Plantago major	broadleaf plantain

*Watch List: Species that are not known to exist currently in Carlsbad Caverns NP, but are present nearby.

Appendix G: Summary of Fire Effects to Selected Vegetation

Plants selected from the park's FMP (CCNP 1995a). Information gleaned from USFS Fire Effects Information System (USFS 2002). Scientific names have been updated according to the USDA Plants Database (USDA NRCS 2001). See the Fire Effects Information System for original citations.

Species	Common Name	Response to Fire
Acacia constricta	whitethorn acacia	fire topkills, but plants resprout
Acer grandidentatum	bigtooth maple	stands burn infrequently; plants killed or topkilled; some resprouting, but vigor thought to be low
Agave lechuguilla	lechuguilla	reproduces vegetatively, sometimes after several seasons, if less than half of leaves scorched; usually dies if more than half scorched; high temperatures depress germination rates; month of burning and available soil moisture affect rate of recovery
Aristida species	three- awn grasses	*A.. purpurea* generally reduced by fire for several growing seasons; rootcrowns are close to surface and easily damaged by fire burning in accumulated litter
Bouteloua gracilis	blue grama	Blue grama has variable fire tolerance; it has fair tolerance when dormant but experiences some damage if burned during active growth, especially during drought. Fire favors blue grama, generally increasing its occurrence, production, and percent cover. Response of blue grama to fire may be dependant on precipitation following the fire; "wet" years tend to increase blue grama yield. Blue grama seed and seedstalk production may also be stimulated by fire. Fire exclusion, and subsequent woody plant invasion, has resulted in blue grama decline. With normal precipitation, blue grama is not harmed by prescribed burning, but may decrease following burning for 2 to 3 years during drought years.
Bouteloua species	other grama grasses	*B. curtipendula* top growth killed; production 50 percent less on burned than unburned areas after dry- year March burn, but studies report burning has little or no effect; rhizomatous form (var. *curtipendula*) harmed by fire in dry years, but not wet; bunchgrass form (var. *caespitosa*) thrives on fire; 40 percent loss in basal cover reported for *B. hirsuta* 1 year after burn, but most studies show no damage after a season or two reduced production; *B. eriopoda* appears to be initially set back by most fires, but increases over the long- term; post- fire drought lengthens recovery; poor seed production and expansion via stolons and layering argue for historically infrequent fires where the grass dominates
Ceanothus greggii	desert ceanothus	cover greatly reduced initially following fire; heat stimulates germination of large numbers of stored seed; fire frequency (5 to 15 years) and fire season (summer/fall) maintains cover
Cercocarpus montanus	mountain mahogany	burns less readily than other shrubs; generally topkilled by fire; sprouts vigorously from root crowns after fires; low seedling establishment post fire

Species	Common Name	Response to Fire
Dasylirion leiophyllum	sotol	fire decreases coverage and frequency significantly; some sprouting from terminal buds; flowering stalks attract lightning and plant tops can spread fire when they detach from stems and roll
Eragrostis intermedia	Plains lovegrass	declines the first growing season after fire but regains or exceeds original cover by the second season
Flourensia cernua	tarbush	no studies, but plant occurs in habitats where fire is rare; fire likely kills it and recovery would be via seeds
Fouquieria splendens	ocotillo	sprout from the root crown following damage from fire, but sprouting is probably dependent on fire severity; fires that occur when plant is leafless may be less harmful
Juglans microcarpa	little walnut	riparian species with few adaptations to fire exhibited; reestablishment presumed via seeds, but closely related black walnut sprouts from stump after fire
Juniperus deppeana	alligator juniper	canopy usually high enough to avoid flames; sprouts from base; young trees more susceptible; burning checked invasion in ponderosa pine
Juniperus pinchotii	redberry juniper	moderate- and low- severity fires can kill seedlings and saplings if basal bud zone unprotected by soil; mature trees with a soil-protected basal bud zone are topkilled by fire; mortality decreases with increased precipitation; sprouts from basal bud zone when topkilled
Larrea tridentata	creosotebush	creosote can resprout after very low density fires, but is frequently killed by fire; normal habitat cannot effectively carry fire; drier than normal conditions increase mortality from fire
Mimosa biuncifera	catclaw mimosa	coverage initially reduced, then sprouts profusely; full recovery within 5 years
Muhlenbergia species	muhly grasses	no difference in coverage and frequency between burned and unburned sites after 3 years
Opuntia phaecantha	prickly pear	32 to 50 percent mortality reported, but cool fire had little effect
Pinus ponderosa	ponderosa pine	very resistant to fire; thick bark, open crown reduce susceptibility; fire kills seedlings and sapling, and prepares seedbed for regeneration
Quercus grisea	gray oak	no studies directly on gray oak; all Arizona oaks sprout prolifically following topkill by fire
Viguiera stenoloba	skeletonleaf goldeneye	topkilled, but resprouts; higher frequencies on burned sites