

## SECTION II

### II.1 Introduction

1a) *State Party:*

United States of America

1b) *Name of World Heritage property:*

Carlsbad Caverns National Park

1c) *Please provide geographical coordinates for the site to the nearest second. (In the case of large sites, please give three sets of geographical coordinates.)*

Geographical coordinate: 104° 22' 51" west longitude and 32° 10' 13" north latitude

1d) *Give date of inscription on the World Heritage List.*

Date: 12/09/1995

1e) *Give date of subsequent extension(s), if any.*

N/A

1f) *List organization(s) responsible for the preparation of this site report.*

Organization #1

Organization Name: Carlsbad Caverns National Park  
Last Name: Barat  
First Name: Chuck  
Title: Deputy Superintendent  
Address: 3225 National Parks Highway  
City: Carlsbad  
State/Prov: New Mexico  
Postal Code: 88220  
Telephone: 505/785-3020  
Fax: 505/785-2133  
Email: Chuck\_Barat@nps.gov

## **II.2 Statement of Significance**

*2a) When a State Party nominates a property for inscription on the World Heritage List, it describes the heritage values of the property which it believes justifies the inscription of the property on the World Heritage List. Please summarize the justification for inscription as it appears in the original nomination of the property.*

### *A. Natural Heritage Property*

#### *i. Major Stages of the Earth's Evolutionary History*

The Capitan Reef Complex, within which park caves formed, dates from the Permian period of geologic time, 280 to 225 million years before present. The exposures of this reef complex and its environs are among the best preserved in the world. Geologists from around the world have come to the park and surrounding area to study these unique features. There have been three distinct cave dissolution periods in the Guadalupe Mountains found within Carlsbad Caverns National Park. The latest began in the early Miocene epoch of the Tertiary period, about 26 million years ago, as faulting and other forces pushed the Guadalupe Mountains upward. As the mountains rose, extensive caves developed, carving out the spectacular passages and rooms of Carlsbad Cavern, Lechuguilla Cave, and other caves in the area. Newly evolving theories show that sulfuric acid played a major role in cave development in the area.

#### *ii. Significant on-going geological processes, biological evolution and man's interaction within the natural environment.*

Geological processes are continuing and are most apparent where rare speleothems continue to form. One of the best examples is in Lechuguilla Cave where helictites are found forming underwater. These unique speleothems are not known to be in any other cave in the world. Many other rare and unique speleothems have been found in Lechuguilla Cave. Human interaction in park caves continues through an active program of exploration and documentation. In 1970, the park had 30 known caves. By 1994, 81 caves had been documented in the park. There are now 106 documented caves in the park. Until 1986, Lechuguilla Cave's known length was only a few hundred feet, but by August 1994, its documented length had grown to 125 kilometers. And, it's still being explored. Lechuguilla Cave has proven to be an excellent, pristine laboratory with scientists and researchers discovering unique microbes in many areas of the cave. Over 600 strains of native microbes have been discovered so far. A team of scientists from the National Aeronautics and Space Administration (NASA) has begun studying Lechuguilla Cave as a possible analog for future biological investigations on Mars.

iii. Superlative Natural Phenomena, Formations, or Features

In the nomination of 1994, the United States noted that the park is most famous for Carlsbad Cavern's large rooms and spectacular beauty. Lechuguilla Cave contains the world's largest and most spectacular accumulation of gypsum chandelier speleothems. Some of these chandeliers are more than 20 feet long, arcing down from the ceiling as large transparent selenite crystals. The cave also contains hair-like gypsum formations over 20 feet long, a large accumulation of hydromagnesite balloons, subaqueous helictites, aragonite "Christmas trees," and a myriad of other calcite and gypsum formations. The cave also contains an estimated 1,000 metric tons of elemental sulfur and massive secondary gypsum deposits related to the sulfuric acid speleogenesis process. The Lechuguilla Cave Protection Act of 1993 extols the cave as "arguably, the finest cave system discovered to date in the United States..." Lechuguilla Cave's known length will continue to increase as the park continues to explore and document more of this amazing cave. The cave has been featured in numerous magazines, and in several television documentaries, including a National Geographic special titled *Mysteries Underground*. Lechuguilla Cave has also been the sole subject of a book published in three languages, *Lechuguilla - Jewel of the Underground*.

2b) *At the time of initial inscription of a property on the World Heritage List, the World Heritage Committee indicates the property's outstanding universal value(s) (or World Heritage value(s)) by agreeing on the criteria for which the property deserves to be included on the World Heritage List. Please consult the report of the World Heritage Committee meeting when the property was listed and indicate the criteria for which the Committee inscribed the property on the World Heritage List. (Choose one or more boxes.)*

Cultural Criteria

- i
- ii
- iii
- iv
- v
- vi

Natural Criteria

- X i
- ii
- X iii
- iv

2c) *At the time of initial inscription, did the World Heritage Committee agree upon a Statement of Significance for the WHS? (Consult the report or minutes of the World Heritage Committee meeting when the property was listed.*

No

2c1) *If YES, please cite it here.*

2c2) *If NO please propose a Statement of Significance for the World Heritage Site based on the consideration given the property by the Committee when it inscribed the property on the World Heritage List. (Note: Following the completion of the Periodic Report exercise, the State Party, in consultation with appropriate authorities, will determine whether to proceed with seeking a Committee decision to approve any proposed Statement of Significance. The Committee must approve any proposed Statement of Significance through a separate, formal process. See 7g.)*

We propose the following for a Statement of Significance:

The Committee inscribed Carlsbad Caverns National Park on the World Heritage List on the basis of criterion (i) and (iii):

Criterion (i): Carlsbad Caverns National Park contains portions of the Permian-aged Capitan Reef Complex, one of the best preserved and accessible complexes available for scientific studies. On-going geological processes continue to form rare and unique speleothems in park caves, notably in Lechuguilla Cave. These include helictites forming underwater and the world's largest and most diverse collection of bacterially assisted "biotherms."

Criterion (iii): Parkcaves, especially Carlsbad Cavern and Lechuguilla Cave, are well known for their great natural beauty. The large rooms and passages as well as the ease of access make Carlsbad Cavern unique among world caves. Lechuguilla is an immense cave system over 180 kilometers in length and contains a great abundance of unique calcite and gypsum speleothems including the world's largest accumulation of gypsum chandeliers, some over six meters in length.

2d) *Since the original inscription of the property on the World Heritage List, has the World Heritage Committee agreed with a proposal by the State Party that the property be recognized for additional World Heritage values and added additional criteria to the inscription as a result of a re-nomination and/or extension of the property?*

No

2d1) *If YES, please indicate which new criteria were added and the date. (dd/mm/yyyy)*

N/A

**II.3 Statement of Authenticity / Integrity**  
**(See Section 2 of the current Nomination Form and Section 4 of the original Form)**

3a) *In addition to meeting one or more of the criteria, which justify inscription on the World Heritage List, a natural or cultural property must meet the appropriate conditions of authenticity and/or integrity, as defined in clauses 24b and 44b of the Operational Guidelines for Implementing the World Heritage Convention. If at the time of inscribing the property on the World Heritage list, the State Party and the International Council on Monuments and Sites, ICOMOS and/or the International Union for Conservation of Nature and Natural Resources, IUCN, evaluated the authenticity and integrity of the property, please cite those evaluations here. (Please quote directly from the nomination, Committee minutes and the Advisory Body's evaluation.)*

The IUCN summary evaluation, prepared in March 1995, states "[o]f the many thousands of caves occurring in North America and in the nearby Guadalupe Mountains, the caves within Carlsbad Caverns National Park are among the most outstanding. They are also notable worldwide because of their size, their mode of origin, and the abundance, diversity and beauty of the decorative rock formations (speleothems) they contain." The evaluation also stated "[t]he only threat that faces the park is oil and gas exploration near its borders" and recommended that a "decision for inscription should be accompanied by an expression of support for creation of a cave protection zone to the north of the park."

The integrity portion of the summary also mentioned the effects guano mining and tourism have had on park caves and stated that "...various management measures were adopted which have largely brought these within acceptable limits." Other integrity items mentioned included a statement on the park's soon-to-be updated General Management Plan, as well as other more specific cave management plans. It also mentioned that "Lechuguilla Cave has been strictly managed allowing only closely monitored visits by researchers"; and, "One unfortunate cave-related loss has been the decline in the Mexican Free-tailed bat population... efforts are being made to reduce further losses" which includes international cooperation with Mexico.

3b) *Have there been significant changes in the authenticity or integrity of the property since inscription?*

Yes

3b1) *If YES, please describe the changes to the authenticity or integrity and name the main causes.*

Since inscription in 1995, two significant changes have occurred, each of which bolsters the authenticity and integrity documentation for Carlsbad Caverns National Park, as defined in section 44b of the Operational Guidelines for Implementing the World Heritage Convention. A summary of these two changes is provided in the following paragraphs.

Discovery and Documentation of 25 additional caves and more than 20 miles (32 km) of new passages:

Since Carlsbad Caverns National Park's inscription as a World Heritage Site in 1995, 25 additional caves have been discovered and documented, bringing the total number of known caves in the park to 106. Documentation includes accurate surveys, an inventory of features, and photo documentation. Lechuguilla Cave increased in surveyed length from 89.35 miles (143.8 kilometers) in December 1995 to 110.67 miles (178.1 kilometers) in October 2003. This added over 20 miles (32.1 kilometers) of new passages, many containing extremely delicate and beautiful speleothems and mineral deposition.

Approval of a new General Management Plan in 1996:

Criteria iv, within section 44b of the Operational Guidelines for implementing the World Heritage Convention, emphasizes the need for a management plan. At the time of inscription, Carlsbad Caverns National Park had a General Management Plan in place and was developing a new plan. This new plan was approved in October 1996 and provides for the comprehensive and long-term management and preservation of resources while allowing a variety of visitor experiences in the park.

A number of implementation plans have been developed since the park's inscription, including the Carlsbad Cavern Resource Protection Plan (2003) that considers the infrastructure built directly over Carlsbad Cavern, and a new Comprehensive Interpretive Plan (draft 2003). The planning efforts that have been completed or are in the process of being completed will provide additional structure and clear management direction for the park. These efforts have contributed to a significant enhancement to the integrity and authenticity of Carlsbad Caverns National Park.

## II.4 Management

### *Management Regime*

4a) *How can the ownership/management of the property best be described? (Select all that apply.)*

- management under protective legislation
- management under contractual agreement(s) between State Party and a third party
- management under traditional protective measures
- other

*Please describe.*

Carlsbad Caverns National Park is owned by the United States Government on behalf of the American people. It is managed by the National Park Service, a federal agency. As a national park it receives the highest level of conservation protection afforded by the federal law of the United States.

4b) *Please indicate under which level of authority the property is managed*

National level

*Please describe*

Carlsbad Caverns National Park is managed by the National Park Service, an agency within the United States Department of the Interior, in the Executive Branch of the United States Government.

4c) *Please describe the legal status of the property. For example, is it a national, provincial or territorial park? A national or provincial historic site?*

The site is a National Park.

4d) *Please provide the full name, address and phone/fax/e-mail of the agency(ies) directly responsible for the management of the property.*

Contact #1

Agency Name: National Park Service - Carlsbad Caverns National Park  
First Name: Deputy Superintendent  
Last Name :  
Address: 3225 National Parks Highway  
City: Carlsbad  
State/Prov: New Mexico  
Postal Code: 88220  
Telephone: 505/785-3020  
Fax: 505/785-2133  
Email: Chuck\_Barat@nps.gov

4e) *Please provide a list of key laws and regulations, which govern the protection and management of the cultural and natural resources of the property.*

The Antiquities Act of 1906  
The National Park Service Organic Act of 1916  
Presidential Proclamation No. 1679 (1923) - Created Carlsbad Cave National Monument  
Public Law 216 (46 Stat. 279) (16 U.S.C. Sec. 207c) (1930) - Created Carlsbad Caverns National Park  
The Wilderness Act of 1964  
The National Environmental Policy Act of 1969  
The NPS General Authorities Act of 1970  
The Endangered Species Act of 1973  
Public Law 95-625 (1978) - Designated wilderness inside park  
The Archeological Resources Protection Act of 1979  
The National Parks Omnibus Management Act of 1988  
The Federal Cave Resources Protection Act of 1988  
The Redwood National Park Act of 1988  
The Lechuguilla Cave Protection Act of 1993  
Code of Federal Regulations - Parks, Forests, and Public Property (CFR 36)  
Compendium of Regulations - Carlsbad Caverns National Park - 2003  
The National Park Service Management Policies 2001

4f) *Please describe the administrative and management arrangements that are in place for the property concerned, making special mention of the institutions and organizations that have management authority over the property and the arrangements that are in place for any necessary coordination of their actions. Make special reference, if appropriate, to the role of First Nations in managing the property.*

The National Park Service, an agency of the United States Government has full management authority over Carlsbad Caverns National Park. The Superintendent of the park has day-to-day management authority and reports directly to the Regional Director, who in-turn, reports directly to the Director of the National Park Service.



4g) *Please also note whether there have been any significant changes in the ownership, legal status, contractual or traditional protective measures, or management regime for the World Heritage Site since the time of inscription.*

There have been no changes since the time of inscription.

4h) *Is there a management plan for the property?*

Yes.

4h1) *If YES, please summarize the plan, indicating if the plan is being implemented and since when, and the URL where the plan can be located, if available. (A copy of the plan should be submitted in December 2004. See Section 8)*

A Final General Management Plan/Environmental Impact Statement (EIS) was completed and released to the public in 1996. The plan sets forth a basic management philosophy and provides strategies for addressing issues and achieving management objectives. The plan provides the framework for management decisions over the next 10 to 15 years to meet the following: (1) Preserve and protect cave resources, the Chihuahuan Desert ecosystem, and the Capitan Reef in Carlsbad Caverns National Park, as well as associated natural and cultural resources; (2) provide a range of opportunities for public use, enjoyment, and understanding, while minimizing impacts on park resources and natural processes; and (3) facilitate research to provide a continuum of information in support of park interpretation, management decisions, and the general body of scientific knowledge.

The Plan/EIS lists three separate, and extensive, alternatives:

Alternative 1 – This is the No-Action Alternative that continues the existing management direction as described in current plans. Under this alternative, the park would “provide for visitor use and respond to resource management issues and concerns as funding allowed, but there would be no major change in management direction.”

Alternative 2 - This is the proposed alternative and “would base resource management decisions on scientific research, inventory, and monitoring. Human activities and facilities would be studied to determine effects of resources, particularly cavern resources. Once these studies are done, a development concept plan would be completed to determine subsurface threats and ways to eliminate or mitigate these threats. Opportunities for visitors would be increased, special off-trail tours would continue, and additional surface trails would be continued. The present visitor center would also be remodeled.

Alternative 3 - This alternative “proposes the removal of many surface functions and facilities above the cavern within five years to ensure the protection of subsurface resources. To replace these functions, a new visitor orientation/transit center and operations center would be developed at the base of the escarpment.” The present visitor center would be modified to focus on interpretation and essential services. A shuttle system would be provided to get visitors from the new visitor center to Carlsbad Cavern and back. Visitor use of Carlsbad Cavern would be monitored and restricted to minimize further impacts to cave resources.

The proposed alternative (Alternative 2) was selected based on environmental considerations as well as a cost versus benefits analysis.

4h2) *If NO, is a management plan under preparation or is preparation of such a plan foreseen for the future?*

N/A

#### *Financial Resources*

4i) *What is the annual operating budget for the property in the current fiscal year? (For sites consisting of more than one property provide the budgets of constituent parts.)*

For fiscal year 2003, the United States Congress appropriated \$5,437,800 USD for the park's annual operating budget.

4j) *Please provide information about the number of staff working at the World Heritage Site (enter figures).*

Full Time: 72  
Part Time: 0.5  
Seasonal: 31  
Other: 4 Full Time, 5 Seasonal (Carlsbad Caverns Guadalupe Mountains Association)  
22 Full Time, 9 Part Time, & 23 Seasonal (Cavern Supply Company - Park Concessioner)  
7.2 Equivalent Full Time positions from 14,908 volunteer hours for 2003

*Please list the job categories of these staff (e.g., Park Superintendent, Historian, Ecologist, Interpreter, General Works/Maintenance Manager) and describe the specialized skills and expertise of the World Heritage Site's staff members.*

Staff for the park is divided into several divisions. Park management includes the Superintendent, Assistant Superintendent, Facility Manager, Chief of Resources Stewardship and Science, Chief of Stewardship Education and Visitor Services, Chief Ranger (Law Enforcement), Revenue and Fee Business Manager, and the Administrative Officer. These management team members all have specialized skills in their respective divisions. Within each division, there are a number of specialized employees that have different job functions. Each division also has a secretary that keeps track of employee time, budget, and a range of other administrative duties.

Facility Management – This division includes heavy equipment operators, elevator mechanics, electricians, laborers, plumbers, painters and an engineer.

Resources Stewardship and Science – This division includes biologists, historians, cave scientists, hydrologists, museum specialists, a search and rescue specialist, and technicians.

Stewardship Education and Visitor Services – This division works with the visiting public daily. They are tour guides, education specialists, volunteer coordinators, visitor contacts, and interpretive specialists.

Protection Rangers - These employees are commissioned law enforcement rangers for the park, and lead emergency services personnel.

Fee Collection - These employees collect money from ticket sales from visitors entering fee areas in park caves.

Administration - These employees include personnel specialists, computer specialists, budget officer, purchasing and contracts officers, and clerical staff.

#### Sources of Expertise and Training in Conservation and Management Techniques

4k) *Please describe any sources of specialized expertise, training, and services that come from sources off-site (e.g., training centers, museum conservation facilities).*

Most Carlsbad Caverns National Park employees possess a considerable amount of specialized expertise and training that has been acquired off-site. This includes National Park Service and other agency training in interpretation, visitor services, law enforcement, natural and cultural resource stewardship, administration, project management, information management, supervision, safety, compliance, and other areas. In addition, some of our staff have advanced degrees in a variety of specialized areas.

The National Park Service also maintains two training centers that provide training classes at their respective locations as well as providing funding for specialized training in other locations. The National Park Service, in conjunction with other federal government agencies, also has specialized training centers that sometimes provide training for staff. An example of this would be the Arthur Carhart National Wilderness Training Center.

Specialized expertise is also provided to Carlsbad Caverns National Park through numerous partner organizations and individuals. Some of these are listed as follows:

The Cave Research Foundation, the Lechuguilla Exploration and Research Network, several grottos (caving clubs) from the National Speleological Society, and numerous individuals provide the park with expertise in exploration and survey, inventory, restoration, and computer data management concerning park caves. These volunteer organizations and individuals provide thousands of hours of time each year to help the park in these projects.

Researchers from various universities and other institutions provide the park with specialized expertise and research endeavors to assist the park in applied and academic fields. This expertise and research is of great benefit to park management. Universities and other institutions recently working with the park include: University of New Mexico, San Diego State University, Western Kentucky University, Northern Kentucky University, New Mexico Museum of Natural History, New Mexico State University, Royal Botanic Garden of Edinburgh (Scotland), University of Wisconsin, University of Texas, New Mexico Institute of Mining and Technology, and others.

The United States Geological Survey has installed and maintains two water gauging stations on flow leaving Rattlesnake Springs, the park's water supply and a significant natural and cultural resource in the park.

The Water Resources Division of the National Park Service provides expertise and assistance with ongoing water rights issues faced by the park.

The University of Arizona is providing expertise and assistance in the formulation of a fire management plan for the park.

Several different volunteer organizations have provided expertise and assistance with trail building and maintenance in the park's backcountry.

The United States Congress recently established a National Cave and Karst Research Institute headquartered in Carlsbad, New Mexico. As the institute becomes more established, the park expects to maintain a close relationship with the institute and utilize specialized expertise and other services that they may provide.

### *Visitation*

4l) *Are there any visitor statistics for the site?*

Yes

4l1) *If YES, please provide the annual visitation for the most recent year it is available, indicating what year that is, a brief summary of the methodology for counting visitors, and briefly describe the trends in visitation. (In describing these trends, please use the year of inscription as a baseline.)*

For calendar year 2002, 476,259 visitors toured park caves. This number was obtained from counting the number of tickets sold. Visitation trends to the park have slowly been dropping. Visitation numbers in 1992 were 688,742 and dropped to a low of 455,618 in 2001. While up slightly from 2001, a slow drop in visitation continues at the park and corresponds to a gradual decrease in visitation to national parks nationwide (7.2% drop between January and May 2003).

4m) *Please briefly describe the visitor facilities at the property.*

Within the park, there is a visitor center where programs are given, tours are assembled, and tickets can be purchased for entry into Carlsbad Cavern or for guided trips to Slaughter Canyon Cave and Spider Cave. The visitor center also houses a bookstore operated by the Carlsbad Cavern Guadalupe Mountains Association, a non-profit organization that sells educational materials and funnels profits to both Carlsbad Caverns and Guadalupe Mountains National Parks; a gift shop and restaurant operated by The Cavern Supply Company, the park concessioner; displays on park resources; and offices for the Stewardship Education and Visitor Services staff. The visitor center is accessed by a seven-mile (11 km) paved road through scenic Walnut Canyon. An additional nine-mile (14 km) gravel road gives visitors the opportunity to see more of Walnut Canyon and provides an overlook into Rattlesnake Canyon. A two-mile (3 km) gravel road gives visitors access to the Slaughter Canyon parking area and trailhead. Additionally, a tougher two-mile (3 km) two-track provides access to the Yucca Canyon trailhead.

4n) *Is there tourism/visitor management plan for the property?*

The General Management Plan, completed in 1996, addresses some of the issues related to tourism. A "draft" Comprehensive Interpretive Plan that addresses tourism and visitor management in more specific detail was completed in August 2003.

4n1) *If YES, please briefly summarize the plan, and provide a URL where the plan can be located.*

The Comprehensive Interpretive Plan (CIP) defines and guides the park-wide interpretive program. This document gives guidance to park staff to help increase people's understanding and appreciation of the significances of Carlsbad Caverns National Park. The CIP is not available on the Internet yet.

Scientific Studies

4o) *Please list key scientific studies and research programs that have been conducted concerning the site. (Please use the year of inscription as a baseline.)*

The National Park Service takes a formal approach to research in national park units and Carlsbad Caverns is no exception. All research projects, whether by outside entities or by park scientists and managers, must go through a compliance process that evaluates the proposed research based on various factors and its potential impacts upon park resources.

Basic data collection, including ongoing exploration, survey, and inventory of park caves and their features continues to be of major importance. Carlsbad Cavern (49.7 kilometers), and Lechuguilla Cave (over 180 kilometers) are the two longest known caves. The number of known caves documented in the park has risen to 106, an increase of 25 since the park nomination was written in 1994.

Cave research, particularly in Lechuguilla Cave and Carlsbad Cavern, has been at the forefront of scientific studies and has covered a number of fields including biology, geology, hydrology, paleontology, and history.

Biology – There are a number of ongoing microbiological studies including one that looks at geologic materials that may serve as biomarkers or indicators of microbial activities. Another project is studying the nature of cave microbial communities and the interactions between communities and their interfaces on rocks, minerals, and in water. Another study is looking at human impacts to native microbial systems.

Geology – One long-term project is to study geologic and geochemical controls that may play a role in cave formation, particularly in Lechuguilla Cave. Another study is locating and identifying minerals and looking at their geochemistry signatures.

Hydrology – A study titled “Determining Water Infiltration Routes From Structures Located above Carlsbad Cavern, Carlsbad Caverns National Park, Carlsbad, New Mexico” was completed in 1997. This focus of this study was “to determine the potential impacts of man-made structures and human activities at the land surface on Carlsbad Cavern.” The study aimed at determining the cave areas most vulnerable to contamination from the land surface through hydrologic pathways, and if impacts from these anthropogenic influences on the hydrology and water quality of the cave system are currently present. There are also a number of cave-related ongoing hydrological studies. This includes baseline hydrochemical analysis of pools in Carlsbad Cavern and human contamination studies of pools in Lechuguilla Cave. One study is looking at infiltration pathways and length of time rates for waters from the Bat Cave Draw parking lot into Carlsbad Cavern. Another study is looking at how recent groundwater development outside the park boundaries may be affecting two deep pools in Lechuguilla Cave that are thought to be connected to the regional Capitan Aquifer.

Paleontology – Two different studies are looking at Late Pleistocene and Holocene paleoclimatology in the southwest from speleothem deposition. A separate study is re-evaluating the taxonomic status of *Tadarida constantinei*, an extinct bat species known only from Slaughter Canyon Cave. This study will also examine other bones recovered from a recent excavation.

Historical – This study will locate, identify, and document the hundreds of historic signatures found throughout Carlsbad Cavern.

Bats that use the park have also been the focus of a number of studies and inventories. A long-term project to monitor the health and size of the park’s most famous bat colony—the Mexican Free-tailed bat—uses infra-red photography to photograph bats when in their roost over a period of days, three separate times during the summer. Area used by the bats in the roost is then translated into a conservative number of bats roosting on that specific day. Though only a few years of data is available so far, trends tend to show a healthy, stable colony. Other bat-related research included feeding habits and foraging area for the Mexican Free-tailed colony, yearly male-to-female ratios for the Mexican Free-tails, and a closer look at two different *Myotis* species that use the deepest areas of Carlsbad Cavern. An interesting project that holds great promise has recently been started using anabat detectors, an Australian electronic device that records and stores bat echolocation patterns. These detectors are tied into data loggers so that areas within Carlsbad Cavern, several major spring areas on the surface, and near the entrances to two other caves in the park with known bat colonies, can be monitored for both types of species and numbers of individuals.

Carlsbad Caverns National Park is one of eleven parks in the Chihuahuan Desert Inventory and Monitoring Network, one of 32 networks established at a national level to begin a long-needed inventory of species and long-term monitoring program to detect changes in the health of park ecosystems. Initial inventory projects have included a vascular plant survey and vertebrate surveys. A small mammal survey was recently completed and a reptile and amphibian survey is currently in process.

Rare, threatened, and endangered species have been a focal point for a number of years. Inventory and monitoring of the federally endangered Sneed pincushion cactus (*Coryphanta sneedii* var. *leei*), particularly in relation to fire and fire suppression, has been ongoing. A survey for endangered owls in the higher elevations of the park is planned for the near future.

The park is also the base for an exotic plant management team that works in nine parks to help identify and eradicate exotic plant species. Additionally, planning has begun on a project to eradicate exotic Barbary sheep from the Guadalupe Mountains in hopes of reintroducing native Bighorn sheep someday in the future. Barbary sheep were introduced to the area in the late 1950s and early 60s.

There are several ongoing important bird studies. Cave swallows live seasonally in the entrance area to Carlsbad Cavern and other caves in the Guadalupe Mountains. Basic data, such as weight and size, have been gathered on these birds for over twenty years. Over 15,000 individuals have been netted during this project. Another important study has concerned nesting migratory birds at the Rattlesnake Springs Unit of the park and the parasitism of nests from Brown-headed Cowbirds.

A bibliography of selected reports and papers from 1995 to 2003 can be found in Appendix A.

4o1) *Please describe how the results of these studies and research programs have been used in managing the World Heritage Site.*

The 1997 Infiltration Study was used as the basis for evaluating and modifying the developed area above Carlsbad Cavern. An environmental assessment with a preferred alternative was completed in 2003 that proposed some structure removal and other mitigative measures to protect the long-term survival of Carlsbad Cavern.

The numerous microbiological studies completed and ongoing in Lechuguilla Cave have provided scientific data to implement changes in how we permit humans to work and travel in the cave.

Information gained from bat studies, particularly those in Carlsbad Cavern, have helped us to understand the ecological needs of the different resident bat species and how the interactions of people, visitors and employees may impact these animals. Measures to limit these impacts have been implemented based on these studies.

Studies on the parasitism of nesting birds at Rattlesnake Springs has given us information on the importance of protecting nests from Brown-headed cowbirds who parasitize other bird's nests. We actively monitor nests and addle cowbird eggs found in parasitised nests.

Exotic plant management has helped us to identify and begin the long process of eradication of numerous exotic plants in the park.

The study of endangered cactus and the role fire has in its long-term survival has helped us develop a draft fire management plan that will reintroduce fire into park ecosystems.

Monitoring activities, particularly in Carlsbad Cavern and Lechuguilla Cave, will give us information on long-term trends and how humans may be continuing to affect cave resources.

4o2) *What role, if any, has the property's designation as a World Heritage Site played in the design of these scientific studies and research programs? For example, has there been a specific effort in these programs to focus on the recognized World Heritage values of the property?*

While the property's designation as a World Heritage Site has not been a driving force in our scientific studies and research programs, the protection of the values for which the property was inscribed have served as a main focus for a number of these studies.

#### *Education, Information and Awareness Building*

4p) *Is there a plaque at the property indicating that it is a designated World Heritage Site?*

Yes

4q) *Is the World Heritage Convention logo used on all of the publications for the property?*

No

4r) *Are there educational programs concerning the property's World Heritage values aimed at schools?*

Yes

4r1) *If YES, please briefly describe these programs.*

The values for which the park was inscribed (many of which overlap with the values for which the park was designated a World Heritage Site) are imparted to visitors on a regular basis and are the background of all interpretive and educational programs given by the park.

Carlsbad Cavern is utilized throughout the southwestern United States and northern Mexico as a classroom by many schools. Curriculum materials have been developed for all grade levels with an emphasis on geology, ecology, biology, and the protection and conservation of park resources. This includes an educational workshop for teachers from Juarez, Mexico, and other northern Mexico school districts.



The park provides a wide range of activities and programs for visitors as well as schools and other community groups. The park provides general information on historical, geological, cultural, and biological aspects via interpretive wayside exhibits in pullout areas along roads. Guided talks and programs are given on desert plant and animal communities, geology, history, and other surface-related activities. The main portion of Carlsbad Cavern (the Main Corridor including the entrance and the Big Room) is open to self-guided tours with informational and educational material available from audio guides and signs along the trails. This material covers numerous subjects including cave development, history of exploration, and biological and geological phenomenon. Ranger-guided tours are also offered for the King's Palace area, along a paved, lit trail, and "off-trail" areas in Left-Hand Tunnel, Lower Cave, and the Hall of the White Giant. Additionally, guided tours are offered to two other caves, Spider Cave and Slaughter Canyon Cave. Other programs and talks are given on numerous subjects throughout each day the park is open. Some of these programs are offered in Spanish.

When Mexican free-tailed bats are in residence in the cave, usually May to October, interpretive talks are given nightly before the bats leave for their foraging activities. This is a popular program and one of the largest bat programs given in the United States, reaching an average of 1,000 visitors on any given summer evening. The bat flight program focuses on species-specific behavioral conditions, other bat species comparisons, and the beneficial aspects of bats with an emphasis on conservation and protection of bat species.

Off-park programs, on many of the same subjects mentioned above, are given to local community and other groups. Programs and talks are also given at conferences and symposia, particularly on recent research and management-related topics, in various locations throughout the United States.

The values for which the park was inscribed are imparted to visitors on a regular basis and are the background of all interpretive and educational programs given by the park.

Last, but not least, safety for visitors and employees is stressed at all levels and through all activities.

*4s) Are there special events and exhibitions concerning the property's World Heritage values?*

Yes

*4s1) If YES, please briefly describe them.*

An annual "Bat-Flight Breakfast" is held the second Thursday in August to encourage visitors to witness the morning return of the Mexican Free-tailed bats to Carlsbad Cavern. This daily, natural event occurs every morning when the bats are in residence, at around dawn. The breakfast, which typically brings in 350 to 500 visitors, is held in celebration of this particular bat species and its role in the ecosystem.

4t) Please briefly describe the facilities, visitor center, site museum, trails, guides and information material that are available to visitors to the World Heritage Site.

The administrative office is located in the town of Carlsbad and provides office space for park administrative functions and services as well as for Guadalupe Mountains National Park and other national park units in the region. This headquarters also houses the park museum. Within the park, a seven-mile (11 km) paved road leads up Walnut Canyon to the visitor center. There are numerous wayside exhibits and a short paved trail to an overlook into Walnut Canyon. The visitor center is where programs are given, tours are assembled, and tickets purchased for entry into Carlsbad Cavern or for guided trips to Slaughter Canyon Cave and Spider Cave. The visitor center also has offices for Stewardship Education and Visitor Services staff, the Carlsbad Cavern Guadalupe Mountains Association, a non-profit organization that sells educational materials and funnels profits into both Carlsbad Caverns and Guadalupe Mountains National Parks, and a gift shop and restaurant for The Cavern Supply Company, the park concessioner. Additionally, the visitor center has exhibits of a historical and natural nature. Also available are brochures on Carlsbad Cavern, a park newspaper, *The Capitan Reef*, and displays and brochures on area attractions. The park also maintains a website where general park information and more specific resources information is available. A newsletter (*Canyons & Caves*) from the Resources Stewardship and Science Division is also available on the website. This newsletter highlights research and other resources management items. The park website can be accessed at: [www.nps.gov/cave](http://www.nps.gov/cave).

Carlsbad Cavern is the main attraction for visitors to the park. Approximately two miles (3 km) of paved, lighted trails are available as a self-guided experience. Wayside exhibits and an audio guide are available to help explain the natural wonders the visitor sees. Members of the interpretive staff rove this portion of the cave to answer questions as well as ensure safety and resource protection. Additionally, the King's Palace area is offered as a guided tour on a paved, well-lit trail. There are also three tours in Carlsbad Cavern that are offered as guided, off-trail trips. These tours range in difficulty from a fairly easy walk with lanterns, to a more challenging climbing and crawling tour where helmets, lights and kneepads are provided. There are also two other caves in the park, Slaughter Canyon Cave and Spider Cave, where these types of tours are offered.

There are a number of hiking trails in the park, ranging from short and easy to long and difficult. A free overnight permit is required for those wanting to camp in the backcountry. Eight other park caves may be entered with a free recreational permits depending on the group's experience level. One additional cave, Ogle Cave, is also available as a guided trip for experienced cavers. It has an entrance pit that is 180-feet (55 m) deep, thus requiring specialized equipment and extensive experience to enter safely.

4u) *What role, if any, has the property's designation as a World Heritage Site played with respect to the education, information and awareness building activities described above? For example, has the World Heritage designation been used as a marketing, promotional, or educational tool?*

The property's designation as a World Heritage Site has played a very small role with respect to education, information, and awareness activities. The values for which the park was inscribed as a World Heritage Site continues to be the driving force for educational, informational, and awareness building activities, but the designation, in and of itself, has not been a focus. The fact that the park is a World Heritage Site has not been used as a marketing, promotional, or educational tool.

## **II.5 Factors Affecting the Property (See Section 5 of the current Nomination Form)**

5) *Please briefly identify factors affecting the property under the following headings: Development Pressures, Environmental Pressures, Natural Disasters and Preparedness, Visitor and Tourism Pressures, Number of Inhabitants Within Property and Buffer Zone and Other - major factors likely to affect the World Heritage values of the property. First discuss those that were identified in the original nomination, in the same order in which they were presented there, then those that have been discussed in reports to the World Heritage Committee since inscription, and then other identified factors.*

*This section should provide information on all the factors which are likely to affect a property. It should also relate those threats to measures taken to deal with them, whether by application of the protection described in Section 4e or otherwise.*

*Not all of the factors suggested in this section are appropriate for all properties. The list provided is indicative and is intended to assist the State Party in identifying the factors that are relevant to each specific property.*

*(In describing these trends, please use the year of inscription as a baseline.)*

*For EACH Factor, please specify the following:  
key actions taken to address factor  
any plans that have been prepared to deal with factor in the future  
whether the impacts of factor appears to be increasing or decreasing, and  
the timeframe for which the comparison is being made.*

### *Development Pressures*

5a) *Provide information about Development Pressures on the following: demolitions or rebuilding; the adaptation of existing buildings for new uses which would harm their authenticity or integrity; habitat modification or destruction following encroaching agriculture, forestry or grazing, or through poorly managed tourism or other uses; inappropriate or unsustainable natural resource exploitation; damage caused by mining; and the introduction of invasive nonnative species likely to disrupt natural ecological processes, creating new centers of population on or near properties so as to harm them or their settings.*

## OIL & GAS DRILLING NEAR THE PARK BOUNDARIES

Northern Boundary: Eddy County, New Mexico (the county in which the park is located), as well as a number of surrounding counties, is a major oil and gas producer. Drilling to the north of the park has been ongoing for a number of years, mostly on federal lands, but some on private property. By the late 1980s, wells were being drilled closer and closer to the park boundary. Eventually, a well was drilled very close to the park boundary and within approximately one mile (1.6 km) of known passages in Lechuguilla Cave with a potential for seven more wells to be drilled nearby. A report was prepared on the probable natural boundaries of Lechuguilla Cave. Using this report, Congress passed the Lechuguilla Cave Protection Act of 1993 establishing a Cave Protection Zone north of the park. This Cave Protection Zone prohibits any future drilling in a designated area and was tied directly to the Dark Canyon Environmental Impact Statement (Dark Canyon EIS) that was being prepared by the Bureau of Land Management concerning oil and gas drilling north of the park. The Lechuguilla Cave Protection Act permanently withdrew 6,280 acres (2541 ha) from any additional oil and gas drilling in this area. There is some concern for existing high-pressured gas wells in the Cave Protection Zone north of the park and located only a couple of miles from the park's two most significant caves, Carlsbad Cavern and Lechuguilla Cave. It is essential for the park to make sure that when these wells are abandoned that they are properly sealed through the cavern-forming limestone and dolomite rock units. Additionally, there are 8,199 acres (3318 ha) of land owned by the state of New Mexico within the Cave Protection Zone identified by the NPS geology panel that was not subject to the Lechuguilla Cave Protection Act or the Dark Canyon EIS.

Southern Boundary: Although there are no concerns over gas leakage into park caves from this direction, Rattlesnake Springs, the park's water supply and oasis for hundreds of species of birds and other animals, could be threatened by future drilling. Rattlesnake Springs is a separate park unit located several miles south of the main park unit. The park is currently seeking funding to determine the route water takes underground from its origin in Slaughter Canyon (on park property) to its outlet at Rattlesnake Springs. Knowledge of where this underground water course runs would allow us to direct any future drilling away from this channel.

Western Boundary: There are no concerns at this time over drilling issues from the west. The park's western boundary abuts the Guadalupe District of the Lincoln National Forest. In 2000, the Lincoln National Forest withdrew 27,299 acres (11,047 ha) of land to the west of the park from any mineral exploration or extraction. This withdrawal is for a 20-year period. The park will need to be vigilant and encourage the US Forest Service to continue this withdrawal action when it is up for review in the year 2020.

Eastern Boundary: In 2000, to the northeast and east of the park, the Bureau of Land Management withdrew from further oil and gas drilling an additional 8,471 acres (3,248 ha) of federal lands and 480 acres (194 ha) of private land with federally owned minerals. A few wells had already been drilled in the area. When abandoned, the NPS will need to make sure that the wells are cased properly through the limestone and dolomite areas. This withdrawal is for a 20-year period and the NPS will need to make sure that this withdrawal is maintained beyond its current limit when it is up for review in 2020.

## PARK INFRASTRUCTURE BUILT DIRECTLY OVER CARLSBAD CAVERN

Since the discovery of Carlsbad Cavern in the late 1800s, buildings and other infrastructure have been built directly above the cave for convenience and ease of visiting and working in the cave. Over the years, parking lots, a maintenance yard, buried gasoline and diesel tanks, housing areas, and a host of other structures have been built, and are still sitting, directly over Carlsbad Cavern. The last major building phase on the top of the cave occurred from the late 1950s to mid 1960s. A significant portion of the infrastructure built over the cave has been designated as a "historic district."

The General Management Plan, released in 1996, authorized a study to look at infiltration routes from surface structures into Carlsbad Cavern, to determine if contaminants were now affecting the cave, and to evaluate the potential for catastrophic events that could lead to even more contamination. This study, completed in 1997, found that some contamination was making its way into the cave and that there was potential for a catastrophic event that could more severely impact the cave. This study recommended removal of a number of structures and uses from above the cave. To help identify problem areas and solutions to these problems, the park most recently completed the Carlsbad Cavern Resource Protection Plan that identified structures, their potential or actual contributions to impacts, and outlined mitigative measures to be undertaken in the near future to better protect Carlsbad Cavern. A Finding of No Significant Impact (FONSI) selecting the proposed alternative was approved by the Regional Director of the National Park Service.

Alternative B (the preferred Alternative) of the Carlsbad Cavern Resource Protection Plan, *"removes the most threatening sources of contamination from above Carlsbad Cavern. This alternative would remove 4.2 acres of pavement and reconfigure the roadway in the Bat Cave Draw parking lot. Contaminated runoff would be reduced by approximately 268,000 gallons per year. It would also remove the Mission 66 housing area and the tennis court, and would relocate the hazardous functions from the maintenance area. Where facilities and pavement remain, specialized storm water systems would be installed to contain spills, and to redirect, collect, and filter storm water runoff. For all activities, construction would take place during the winter to reduce the effects of these activities on visitors and wildlife, particularly bats."* The plan would also replace the existing sewer line collection system and reroute the sewage outfall line to limit its alignment over the cave.

Items in this plan will be implemented over the next 10 years for the long-term protection of Carlsbad Cavern.

### *Environmental Pressures*

5b) *Environmental pressures can affect all types of property. Air pollution can have a serious effect on stone buildings and monuments as well as on fauna and flora. Desertification can lead to erosion by sand and wind. What is needed in this section is an indication of those pressures which are presenting a current threat to the property, or may do so in the future, rather than a historical account of such pressures in the past.*

## AIR QUALITY DETERIORATION

Carlsbad Caverns National Park is a Class I air quality area. Air quality, particularly the visual aspects affecting the view shed, has deteriorated over the years. While still in excellent shape overall, the view shed appears to be threatened in the long term. These long-term threats are from recent power plant construction in northern Mexico about 300 to 500 miles (483 to 805 km) south of the park, and continued population growth in El Paso, Texas, and adjacent Juarez, Mexico, area located about 150 miles (241 km) to the west of the park, and the probable development of hundreds, if not thousands, of new oil and gas wells to be drilled south and west of the park.

Nearby Guadalupe Mountains National Park is also considered a Class I air quality area and maintains an air-quality monitoring station that is one of a network of stations throughout the United States. Information from this air-quality station is used to monitor air quality at the park.

## EXOTIC SPECIES IDENTIFICATION AND ERADICATION

There has been a growing concern over exotic species moving into all national parks including Carlsbad Cavern. Barbary sheep, an exotic species, were introduced in the area in the 1950s with the first sighting of one in the park occurring in 1959. Planning has begun on a project to learn more about the species' impacts on the park to determine if eradication is feasible. If deemed feasible, it may be possible to reintroduce native Bighorn sheep into the park in the future. Bighorn were once native to the park, but disappeared from the area in the 1930s and 1940s.

Exotic plants have moved into numerous niches in park ecosystems in recent years. A problem in most parks, the National Park Service initiated a Service-wide exotic plant management program. The park is the base for an exotic plant management team (Chihuahuan Desert - Southern Short Grass Prairie Exotic Plant Management Team) that works in Carlsbad Caverns National Park and ten other national park units to help identify and eradicate exotic plant species.

### *Natural Disasters and Preparedness*

*5c) This section should indicate those disasters which present a foreseeable threat to the property and what steps have been taken to draw up contingency plans for dealing with them, whether by physical protection measures or staff training. (In considering physical measures for the protection of monuments and buildings it is important to respect the integrity of the construction.)*

While no natural disasters are foreseen for the park, park staff maintains a high level of preparedness for emergency situations including EMS ratings for a number of park staff, a Search and Rescue team that includes a heavy emphasis on vertical rescue techniques, and an overall preparedness for bomb threats and other human-induced situations.

### *Visitor and Tourism Pressures*

5d) *In completing this section what is required is an indication of whether the property can absorb the current or likely number of visitors without adverse effects (i.e., its carrying capacity). An indication should also be given of the steps taken to manage visitors and tourists. Possible impacts from visitation that could be considered include the following:*

- i. damage by wear on stone, timber, grass or other ground surfaces ;*
- ii. damage by increases in heat or humidity levels;*
- iii. damage by disturbance to the habitat of living or growing things; and*
- iv. damage by the disruption of traditional cultures or ways of life.*

### VANDALISM IN CARLSBAD CAVERN

Vandalism in Carlsbad Cavern was briefly mentioned in the park nomination for inscription dated 1994 and in the IUCN Summary dated March 1995. The following is a more detailed account of vandalism history, mitigative measures put in place to stem the bulk of the vandalism, and future directions the park is taking to monitor the situation.

Carlsbad Cavern remains one of the only heavily decorated caves in the world with a self-guided commercial tour through it. Begun in the early 1970s in response to large numbers of visitors coming to the cave, self-guided tours have had a number of positive and some negative aspects to them. With visitor numbers spiraling upward in the early 1970s and guided tours containing 750 people per tour, a decision by park management was made to open the cave to self-guided tours. This decision allowed an unrestricted number of people to visit Carlsbad Cavern and gave them the opportunity to view the cavern at their own pace. This decision also gave hundreds of thousands of visitors a year a mostly unsupervised trip through the cavern, resulting in vandalism.

Formation breakage counts were periodically made to assess the extent of vandalism occurring along the paved visitor routes. The last count, made in 1993, showed that between 1985 and 1993, over 16,000 formations or pieces of formations had been removed from the cave. Clearly there was a problem that had to be corrected. In 1994, the decision was made to return the King's Palace, a very fragile area along the tour that was suffering significant vandalism, to guided tours. The General Management Plan released in 1996 also advocated the installation of stainless steel railings throughout the paved areas of the trail. Before the railings were installed, it was easy to step off the trail throughout most of the visitor areas. Sensors placed in the cave before and after the railings were installed showed that visitors getting off the trails stopped in most places as soon as the railings were installed. The installation of railings was completed in 2001.

These two actions have made a major difference in stopping—or at least significantly slowing—vandalism throughout the visitor tour areas of Carlsbad Cavern. Isolated incidents still show that unsupervised visitors occasionally get off the paved trails and do damage to floor or wall features. The park is currently seeking funding to target specific areas where the use of computer enhanced photos and laser scans will help us determine the rate of formation loss that may still be occurring. The park will also be seeking funding to increase staff numbers in the cave during visitation hours to improve our presence and act as a deterrent to potential vandals.

*Number of Inhabitants Within Property and Buffer Zone*

5e) *Include the best available statistics or estimate of the number of inhabitants, if any, within the property and any buffer zone and describe any activities they undertake which affect the property.*

At this time, there are 2 permanent Law Enforcement officials, 1 permanent biologist, and, at any given time, 10 to 20 seasonal residents living at the park. The biologist lives at Rattlesnake Springs in a historic house. The rest live in mostly historic buildings directly on top of Carlsbad Cavern. Residents are limited in the types of activities they can engage in while living in the park.

In the areas adjacent to the park, there are 10 to 15 ranches that house approximately 30 to 50 individuals. Most activities by these ranches do not affect the park property, though water withdrawals for crops near Rattlesnake Springs does affect spring flow during the growing season.

5f) *List Other Factors*

N/A



## **II.6 Monitoring**

### *Administrative Arrangements for Monitoring Property*

6a) *Is there a formal monitoring program established for the site? In this case, "monitoring" means the repeated and systematic observation and collection of data on one or more defined factors or variables over a period of time.*

Yes

6a1) *If YES, please describe the monitoring program, indicating what factors or variables are being monitored and which partners, if any, are or will be involved in the program.*

There is a limited cave monitoring program in place. The program involves temperature and barometric pressure monitoring in 14 locations throughout Carlsbad Cavern and in 5 locations in Lechuguilla Cave. An active program of using infrared photography to photograph Mexican free-tailed bats in their roost in Carlsbad Cavern has been in place for 8 years. This program is designed to look at long-term population trends for the colony.

Other monitoring programs involve bird-nest parasitism by Cowbirds at Rattlesnake Springs, fire effects on an endangered cactus, and a mountain lion DNA study.

A major Inventory and Monitoring program initiated throughout the National Park Service is in the beginning stages at the park. Carlsbad Caverns National Park is one of eleven parks in the Chihuahuan Desert Inventory and Monitoring Network; each park will begin a long-needed inventory of species and long-term monitoring of the health of park ecosystems. Initial inventory projects have included a vascular plant survey and vertebrate surveys. A small mammal survey was recently completed and a reptile and amphibian survey is currently in progress. The program will eventually identify most species in the park and devise monitoring protocols to track trends and long-term survival of park ecosystems.

### *Key Indicators for Measuring State of Conservation*

6b) *At the time of inscription of the property on the World Heritage list, or while in the process of reviewing the status of the property at subsequent meetings, have the World Heritage Committee and the State Party identified and agreed upon key indicators for monitoring the state of conservation of the property's World Heritage values?*

No

6b1) *If YES, please list and describe these key indicators, provide up-to-date data with respect to each of them, and also indicate actions taken by the State Party in response to each indicator.*

N/A

6b2) *If NO key indicators were identified by the World Heritage Committee and used so far, please indicate whether the World Heritage Site management authority is developing or plans to develop key indicators for monitoring the state of conservation of the property's World Heritage Values.*

The National Park Service is in the process of developing key ecological indicators that will identify vital signs of ecosystem health and a monitoring program that will be able to determine and track the state of conservation of the property over the long term. The discussion in 6a1 of the Chihuahuan Desert Inventory and Monitoring Network provides some information on steps being taken to develop key indicators. It is hoped that this program will be in place in the next several years.

*Results of Previous Reporting Exercises*

6c) *Please describe briefly the current status of actions the State Party has taken in response to recommendations from the World Heritage Committee at the time of inscription or afterwards, through the process known as "reactive reporting." (Note: The answer to this question will be "not applicable" for many sites.)*

Not Applicable.

## **II.7 Conclusions**

### *World Heritage Values*

7a) *Please summarize the main conclusions regarding the state of the World Heritage values of the property (see items II.2. and II.3. above).*

Carlsbad Caverns National Park was nominated as a World Heritage Site on the basis of criteria i, ii, and iii for natural properties. Criteria i requires nominated sites "to be outstanding examples representing major stages of earth's history, including...significant on-going geological processes in the development of landforms." Criteria ii requires a nominated site "be outstanding examples representing significant on-going ecological and biological processes...." Criteria iii requires nominated sites "contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance."

Carlsbad Caverns National Park was inscribed on the basis of criteria i and iii. The significance of the park in reference to criteria ii is only now beginning to be documented and understood. Studies, in particular, on the microbial ecosystems found in Lechuguilla Cave, Spider Cave, and Carlsbad Cavern are yielding amazing results. Microbial ecosystems found within park caves are changing research efforts in caves across the world and the park may in the future seek to expand the inscription values to criteria ii also.

The park-generated Nomination and the IUCN Technical Evaluation for Carlsbad Caverns National Park provides extensive information and documentation on how the criteria were satisfied. Carlsbad Caverns National Park was inscribed in 1995 as a World Heritage Site.

As of 2003, the validity of the two criteria that Carlsbad Caverns National Park was inscribed for remains intact and, in fact, has been enhanced by the additional discovery and documentation of 25 previously unknown caves and over 20 miles (32.1 kilometers) of new passages within Lechuguilla Cave. This addition brings Lechuguilla Cave to a length of 111.19 miles (180.1 kilometers) as of January 2004, and it remains the fifth longest known cave in the world. Along with these discoveries, an extensive amount of scientific research has been accomplished in the park since 1995.

The 1995 nomination for Carlsbad Caverns National Park did include a statement of significance, but was not approved during the inscription process. A new statement of significance is submitted in this report to the World Heritage Committee for a decision on its acceptance. The proposed statement of significance describes the exceptional values of Carlsbad Caverns National Park and the significance it holds for the world.

## *Management and Factors Affecting Site*

7b) *Please summarize the main conclusions regarding the management of and factors affecting the property (see items II.4. and II.5. above).*

Carlsbad Caverns National Park is a unit of the National Park Service, an agency of the government of the United States of America. The agency and the park enjoy broad support from the American public as well as from the legislative branch of the government. There are numerous laws that have been enacted to create and maintain the integrity of Carlsbad Caverns National Park. Additionally, numerous laws have been enacted to mandate protection of park resources.

A new General Management Plan was approved in 1996 to guide the park management for 10 to 15 years.

The federal government supports the park through appropriations that in 2002 reached 5.4 million dollars. For 2003, 72 full-time positions, 0.50 part-time positions, and 31 seasonal positions were allotted for the management of the park. Additionally, 7.2 equivalent full-time positions were donated from 14,908 volunteer hours. The concessioner, Cavern Supply Company, provided food service and a gift shop in support of the park operations utilizing 22 full-time, 9 part-time, and 23 seasonal employees during 2003. The Carlsbad Cavern Guadalupe Mountains Association, a non-profit organization, provided a bookstore where educational materials are available for purchase utilizing 4 full-time and 5 seasonal employees during 2003.

In 2002, 476,259 visitors toured Carlsbad Cavern and other park caves. To support future park advocates and visitors, the park will be rehabilitating its visitor center beginning in late 2004, and the parking lots, entrance road, and sewer lines in 2007.

Research has been a valuable asset for the park with good science serving as the basis for a number of management decisions in recent years. The discovery of unique microbial ecosystems in Lechuguilla and other park caves has changed how caves are managed in the park. These changes have helped protect these fragile ecosystems while still allowing access to the caves for a variety of reasons.

Education continues to be a valuable tool with the development of school curriculums, on- and off-site talks, and new ways of educating the public about park values.

Threats to Carlsbad Caverns National Park have been documented from development, environment and tourism pressures. Discussions of these threats are found in section II5a, b and d.

## 1 - Development Pressures

Since inscription, the park has worked with two other Federal agencies, the Bureau of Land Management and the US Forest Service, to prevent new oil and gas leasing and exploration operations from occurring on additional federal properties surrounding the park, particularly to the west, north and east. The Bureau of Land Management withdrew approximately 8,500 acres (3,440 ha) north and east of the park from any additional activities. To the west, the US Forest Service withdrew about 20,000 acres (8,094 ha) of federal lands from any additionally drilling.

The park developed the Carlsbad Cavern Resource Protection Plan and Environmental Assessment that looked at infrastructure built directly over Carlsbad Cavern and made a decision to remove or mitigate perceived problems from these man-made structures. The elements listed in this plan will direct future infrastructure activities including removal or mitigation of identified structures.

## 2. Environment Pressures

The park is using data from the nearby Guadalupe Mountains National Park air quality monitoring system to track long-term changes in air-quality in the area.

Exotic species (both plant and animal) have been identified and steps are being taken to eradicate the exotic plant species. Barbary sheep are being studied to understand impacts they may cause and to determine the feasibility of removing them from the park.

## 3. Tourism Pressures

Steps have been taken to stop, or at least slow, vandalism in Carlsbad Cavern. Funding is being sought to monitor specific locations for vandalism rates. If monitoring reveals a continued vandalism problem, additional measures will be developed to stop it.

### *Proposed Future Action(s)*

*7c) Please describe briefly future actions that the State Party has approved to ensure the conservation of the World Heritage values of the property.*

Construction to rehabilitate the visitor center is planned to begin in one year. This will be a major effort and will completely rehabilitate the existing visitor center structure. The rehabilitation effort is schedule to cost \$7.2 million USD. Along with that effort, a reworking of the paved Walnut Canyon Drive, including parking lots above Carlsbad Cavern, is also scheduled to take place after the visitor center is completed. This scheduled work will cost \$2.45 million USD. At the same time, the replacement of the entire sewer system is expected to occur at a cost of \$2.57 million USD.

The park also plans to be more proactive in letting the public know that Carlsbad Caverns National Park has the distinct honor of being a World Heritage Site.

*Responsible Implementing Agency(ies)*

7d) *Please identify the agency(ies) responsible for implementation of these actions described in 7c, if different from those listed in Section II.4.*

Same information as given in Section II.4.

*Timeframe for Implementation*

7e) *If known, or predictable, please provide a timeline for the implementation of the actions described in 7c.*

Visitor Center Rehabilitation: Will be completed within 2 years.  
Comprehensive Interpretive Plan: A draft was completed in August 2003.  
Training and Emergency Preparedness: Ongoing implementation.  
Improvement to the Monitoring Program: 2 to 4 years

*Needs for International Assistance*

7f) *Is it anticipated that International Assistance, through the World Heritage Fund, will be requested for any of the planned actions described above?*

No

*Potential Decisions for the World Heritage Committee*

7g) *Please indicate if the World Heritage Site management authority has preliminarily identified, as a result of this reporting exercise, an apparent need to seek a World Heritage Committee decision to change any of the following:*

*(Note: Following completion of the Periodic Report exercise, the State Party, in consultation with appropriate authorities, will determine whether to proceed with seeking a Committee decision on these changes. To request such changes, the State Party will need to follow a separate, formal process, subsequent to submitting the report.)*

- change to criteria for inscription
- change to Statement of Significance
- X proposed new Statement of Significance, where previously missing
- change boundaries or buffer zone

## II.8 Documentation

**(See Section 7 of the current Nomination Form and Section 3 of the original Nomination Form)**

8a) Please review the original nomination for the property to determine whether it is necessary or advisable to supply, update or amend any of the following documentation for the World Heritage Site. Indicate what documentation will be supplied to supplement the information found in this report. (This documentation should be supplied at the time the Periodic Report is submitted to the World Heritage Centre, in December 2004.)

- a) Photographs, slides and, where available, film. This material should be accompanied by a duly signed authorization granting, free of charge to UNESCO, the non-exclusive right for the legal term of copyright to reproduce and use it in accordance with the terms of the authorization attached.
- X b) Topographic or other map or site plan which locates the WHS and its boundaries, showing scale, orientation, projection, datum, site name, date and graticule.
- X c) A copy of the property management plan.
- X d) A Bibliography consisting of references to all the main published sources on the World Heritage Site, compiled to international standards.

URL: <http://www.nps.gov/cave>

Description: Website for general and specific information concerning Carlsbad Caverns National Park.

8b) Do you have a digital map of the WHS, showing its location and boundaries?

Yes

8bi) If yes, in what format(s) is the map?

There are several formats and sets of data available.

8bii) Is it published on a publicly-accessible website?

Yes

8biii) If yes, please provide the URL of the site where the map can be found. Must be a valid URL.

<http://maps.nps.gov/> - An interactive map showing the park boundary, major roads and hydrology, and base imagery can be found at this URL.

<http://maps2.itc.nps.gov/nps/parkatlas.jsp?zoomtopark=Carlsbad%20Caverns%20National%20Park> - This is the direct link for the interactive map listed above.

[http://www.nps.gov/gis/park\\_gisdata/newmexico/cave.htm](http://www.nps.gov/gis/park_gisdata/newmexico/cave.htm) - More geographic data and metadata are available on-line at this URL from the National Park Service Data and Information Clearinghouse. Available data include park and wilderness boundaries, special management boundaries (including the Lechuguilla Cave Protection Area), digital elevation models, hypsography and hydrography, fire history, and limited biological data.



## APPENDIX A - SELECTED BIBLIOGRAPHY

- Atkinson, G. L., *Washington Ranch Gas Field, Eddy County, New Mexico*. Information Report. 1996.
- Barnes, Myra. 2001. *Counting Cougars*. Canyons & Caves No. 23. pgs. 3-4.
- Barnes, Myra. 2001. *Identifying Flying Bats*. Canyons & Caves No. 22. pgs. 3-4.
- Barnes, Myra. 2002. *New Discoveries from Bat Echolocation Patterns*, Canyons & Caves No. 27. pgs. 3-5.
- Barnes, Myra and Dale Pate. 2002. *Ringtails in Carlsbad Cavern*. Canyons & Caves No. 27. pgs. 2-3.
- Best, Troy L. and Celia Lopez-González, 2001. *Survey of Wintering Sites of Mexican Free-tailed Bats (Tadarida Brasiliensis mexicana) from Carlsbad Cavern, New Mexico Phases 1 and 2: Habitat Evaluation and Search for Wintering Sites*, Research Report.
- Best, Troy L. and Kenneth N. Geluso, 2000. *Foraging Areas of Mexican Free-tailed Bats (Tadarida Brasiliensis mexicana) Roosting in Carlsbad Cavern, New Mexico: Final Report of Research Conducted 1997-2000*, Research Report.
- Beymer, Renée and Diane Dobos-Bubno. 1999. *Cactus Morphometrics made Easy (Well, Easier...)*. Canyons & Caves No. 15. pgs. 3-4.
- Bigelow, Jim, 1998. *Biomes: The Promise of Cave-dwelling Microbes*, NSS News, May 1998, pg. 145.
- Bigelow, Jim and Larry Mallory. 1999. *Update on Research on Microbes from Lechuguilla Cave*, Unpublished Report.
- Boston, Penelope J., 1999. *A Bit of Peace and Quiet: The Microbes of Lechuguilla*, NSS News, August 1999, pg. 237.
- Boston, Penelope. 2000. *Life Below and Life 'Out There'*, Geotimes, August 2000, pgs. 14-17.
- Boston, Penelope J., 1999. *Red Lake (Lechuguilla Cave) Contamination Studies: An Assessment of the Situation*, Research Report.
- Bowen, Erika M. 1998. *Hydrogeology of Rattlesnake Springs: Eddy County, New Mexico*. Master's Thesis, New Mexico Institute of Mining and Technology.
- Brook, Mark, 1996. *Infiltration Pathways at Carlsbad Caverns National Park Determined by Hydrogeologic and Hydrochemical Characterization and Analysis*. Master's Thesis, Colorado School of Mines.
- Burger, Paul. 2003. *2002 Summary of Science in the Caves of Carlsbad Caverns National Park*. Canyons & Caves No. 28. pgs. 9-10.
- Burger, Paul. *Water Movement in Carlsbad Cavern*. Research Report.

- Burger, Paul, 2002. *Cave Science at Carlsbad Caverns National Park: 2000-2001 Review*, Canyons & Caves No. 24, p. 9.
- Burger, Paul, 2000. *Walking Guide to the Geology of Carlsbad Cavern*, Internal Document.
- Chen, Tou-Rong, Yung-Sung Cheng, and Piotr T. Wasiolek. 1994. *Air Quality in the Carlsbad Cavern*. Annual Report of the Inhalation Toxicology Research Institute. pgs. 8-9.
- Cheng, Yung-Sung, Tou-Rong Chen, Piotr T. Wasiolek, and Amila Van Engen. 1997. *Radon and Radon Progeny in the Carlsbad Caverns*. Aerosol Science and Technology, Vol. 26, pgs. 74-92.
- Cheng, Yung-Sung, Tou-Rong Chen, Piotr T. Wasiolek and Amelia Van Engen. 1995. *Air Quality and Radon Exposure in the Carlsbad Caverns*. Research Report.
- Cowley, Jill. 2001. *Cultural Landscape Inventory-Rattlesnake Springs: Revised 2001*. NPS Report.
- Davis, Donald G., *Extraordinary Features of Lechuguilla Cave, Guadalupe Mountains, New Mexico*, Journal of Cave and Karst Studies, Vol. 62, No. 2, pgs. 147-153.
- Dawson, Helen E. 1998. *Hydrochemistry of Lechuguilla Cave: Final Report Summary*. Research Report.
- DuChene, Harvey R., *Bedrock Features of Lechuguilla Cave, Guadalupe Mountains, New Mexico*, Journal of Cave and Karst Studies, Vol. 62, No. 2, pgs. 109-119.
- DuChene, Harvey R., 1998. *Draft Mineral Inventory of Lechuguilla Cave*, Research Report.
- DuChene, Harvey R., David H. Jagnow, Lloyd Pray, and J. Michael Queen. 1993. *Report of the Guadalupe Geology Panel to the National Park Service*.
- Elliott, William R., 1998. *A Survey of Ecologically Disturbed Areas in Carlsbad Cavern, New Mexico*, Research Report.
- Emmons, Gavin. 2000. *Mountain Lion Monitoring Project: Spring 2000*. Canyons & Caves No. 3-5
- Emmons, Gavin. 2000. *Small Mammal Trapping in the Park*. Canyons & Caves No. 20. pgs. 3-5.
- Fagerstrom, J.A., and O. Weidlich, *Origin of the Upper Capitan-Massive Limestone (Permian), Guadalupe Mountains, New Mexico-Texas: Is it a Reef?*, Geological Society of America Bulletin, February 1999, pgs. 159-176.
- Foos, Annabelle M., Ira D. Sasowsky, Edward J. LaRock, and Patricia N. Kambesis, *Detrital Origin of a Sedimentary Fill, Lechuguilla Cave, Guadalupe Mountains, New Mexico*, Clays and Clay Minerals, Vol. 48. No. 6, pgs. 693-698, 2000.

- Forbes, Jeffrey R. 2000. *Geochemistry of Carlsbad Cavern Pool Waters, Guadalupe Mountains, New Mexico*. Journal of Cave and Karst Studies, Vol. 62, No. 2. pgs. 127-134.
- Ford, Derek C., *Interim Report upon Radiometric Dating and Stable Isotope Paleoclimate Analyses of Samples from Lake of the Clouds, Carlsbad Cavern*, Unpublished Report, 1996.
- Geluso, Kenneth N. and Troy L. Best, *Radiotracking the Fringed Myoits (Myotis thysanodes) in Carlsbad Cavern, New Mexico*, Research Report, 1995.
- Geluso, Kenneth N. and Troy L. Best, *Summer Use of Carlsbad Cavern by Cave Myotis (Myotis velifer)*, Research Report, 2001.
- Goodbar, James R., *Oil and Gas Drilling in Cave and Karst Areas*, NSS News, April 1997, pgs. 104-105.
- Hadingham, Evan., *Subterranean Surprises*, Smithsonian Magazine, October 2002, pgs. 68-74.
- Harwood, Gill M., *Large Scale Channel Development within the Capitan Reef Complex: Evidence from Carlsbad Cavern*, SEPM Core Workshop No. 13 Report, 1989.
- Hill, Carol A. 2002. *Overview of the Geologic History of Cave Development in the Guadalupe Mountains, New Mexico*. Journal of Cave and Karst Studies, Vol. 62, No. 2, pgs. 60-71.
- Hill, Carol A. *Geologic Walking Tour of Carlsbad Cavern*. New Mexico Geological Society Guidebook, pgs. 117-128.
- Hill, Carol A. 1999. *Origin of Caves in the Capitan*. SEPM Special Publication No. 65, pgs. 211-222.
- Hunter, Andrea J., *Environmental Disturbance of Oligotrophic Bacteria and Effects on Water Quality in Deep Karstic Pools*, Masters Thesis, University of New Mexico, 2001.
- Jablonsky, Pat. 1996. *Chiropteran Studies-Lechuguilla Cave*. Research Report.
- Jablonsky, Pat. 1999. *Carbon14 Analysis of Chiroptera Specimens and Guano Deposits, Carlsbad Cavern, Carlsbad Caverns National Park*. Research Report.
- Jablonsky, Pat, Sandy Kraemer, and Bill Yett. 1994. *Develop Preventative Measures for Future Accumulations of Cave Lint*, Research Report from Wind Cave National Park.
- Jagnow, David H., Carol A. Hill, Donald G. Davis, Harvey R. DuChene, Kimberley I. Cunningham, Diana E. Northup, and J. Michael Queen. 2000. *History of the Sulfuric Acid Theory of Speleogenesis in the Guadalupe Mountains, New Mexico*. Journal of Cave and Karst Studies. Vol. 62. No. 2, pgs. 54-59.

- Lambert, Steven J. 1999. *Draft-Recharge to the Unsaturated Zone in Fractured Limestone: Stable-Isotopic Characteristics of Infiltration*. Sandia National Laboratory Report.
- Mallory, Larry M., J. Bigelow, and M. Hacker, *Isolation of Cancer Chemotherapeutic Natural Products from Cave Microorganisms*, Plant and Soil Science, 1996.
- Mallory, Larry. 1995. *Numerical Taxonomic Comparison of Two Freshwater Microbial Communities in Lechuguilla Cave, Carlsbad Caverns National Park*, Unpublished Report.
- McLean, John, Charles Russell, Robert Buecher and Raymond Nance. 1996. *Microclimate Measurements in Carlsbad Cavern, 1995-1996*. Report to the National Park Service.
- Michie, Neville. 1999. *Preliminary Microclimate Survey in Carlsbad Cavern*. Unpublished Report.
- Miller, Garrett F. 2002. *The Popcorn of Spider Cave: Past and Present*. Senior Thesis.
- Mulheisen, Michael, *Foraging Ecology of the Mexican Free-tailed Bat (Tadarida brasiliensis mexicana) at Carlsbad Caverns National Park, Eddy Co., New Mexico: Activity Patterns*, Research Report, 1999.
- Nagihara, Seiichi, Ramey Goss, and Bryan Musgrave. 2002. *Three-dimensional Laser Scanning of Speleothems in the Carlsbad Caverns*. Research Report.
- Northup, Diana E. 1997. *Balancing Conservation of Unusual Cave Microbial Communities with Exploration and Research in Lechuguilla Cave, Carlsbad Caverns National Park, New Mexico: Final Report*. Research Report.
- Northup, Diana E., Clifford N. Dahm, Leslie A. Melim, Michael N. Spilde, Laura J. Crossey, Kathleen H. Lavoie, Lawrence M. Mallory, Penelope J. Boston, Kimberley I. Cunningham, Susan M. Barns. 2000. *Evidence for Geomicrobiological Interactions in Guadalupe Caves*. Journal of Cave and Karst Studies, Vol. 62, No. 2, pgs. 80-90.
- Northup, Diana E. and Kathleen H. Lavoie. 2001. *Geomicrobiology of Caves: A Review*. Geomicrobiology Journal, Vol. 18. pgs. 199-222.
- Northup, Diana E., Deborah L. Carr, Lauraine K. Hawkins, Patricia Leonard, and W. Calvin Welbourn. 1992. *Lechuguilla Cave Biological Inventory*. Research Report. 161 pgs.
- Northup, Diana E. and Clifford S. Crawford. 1991. *Patterns of Fecundity and Age Class Distribution of Rhabdiorid "Camel Crickets" (Ceuthophilus longipes and C. carlsbadensis) from Carlsbad Cavern*. The American Midland Naturalist, No. 127, pgs. 183-189.
- Palmer, Arthur N. and Margaret V. Palmer. 2000. *Hydrochemical Interpretation of Cave Patterns in the Guadalupe Mountains, New Mexico*. Journal of Cave and Karst Studies, Vol. 62, No. 2, pgs. 91-108.

- Palmer, Arthur N. 1991. *Origin and Morphology of Limestone Caves*. Geological Society of America Bulletin, Vol. 103, pgs.1-21.
- Pate, Dale L. 2000. *Lower Cave Carlsbad Cavern Artifact Removal Project 1998-2000*. Research Report.
- Pate, Dale. L. 1999. *Management Tools for Supporting Conservation Ethics*. Unpublished Report.
- Plank, Alexandria. 2001. *Air Circulation Mechanisms in Carlsbad Caverns National Park, Carlsbad, New Mexico*. Research Report. Pomona College Geology Dept.
- Polyak, Victor J. and Cyndi J. Mosch. 1996. *Metatyuyamunite from Spider Cave, Carlsbad Caverns National Park, New Mexico*. The NSS Bulletin, Vol. 57, pgs. 85-90.
- Polyak, Victor J. and Necip Guven.1996. *Alunite, Natroalunite and Hydrated Halloysite in Carlsbad Cavern and Lechuguilla Cave, New Mexico*. Clays and Clay Minerals, Vol. 44, No. 6, pgs. 843-850.
- Polyak, Victor J. and Paula P. Provencio. 2000. *Summary of the Timing of Sulfuric - Acid Speleogenesis for Guadalupe Caves Based on Ages of Alunite*. Journal of Cave and Karst Studies, Vol. 62, No. 2, pgs. 72-74.
- Polyak, Victor J. and Necip Guven. 2000. *Clays in Caves of the Guadalupe Mountains, New Mexico*. Journal of Cave and Karst Studies, Vol. 62, No. 2, pgs. 120-126.
- Polyak, Victor J., Haraldur R. Karlsson, and Paula Provencio. 2001. *Cave-Authigenic Dolomite from the Guadalupe Mountains, New Mexico*. Research Report.
- Polyak, Victor James and Necip Guven. 2000. *Authigenesis of Trioctahedral Smectite in Magnesium-Rich Carbonate Speleothems in Carlsbad Cavern and Other Caves of the Guadalupe Mountains, New Mexico*. Clays and Clay Minerals, Vol. 48, No. 3, pgs. 317-321.
- Polyak, Victor J. and Yemane Asmeron. 2001. *Late Holocene Climate and Cultural Changes in the Southwestern United States*. Science, Vol. 294, pgs. 148-151.
- Polyak, Victor James. 1992. *The Mineralogy, Petrography and Diagenesis of Carbonate Speleothems from Caves in the Guadalupe Mountains, New Mexico*. Master's Thesis.
- Polyak, Victor James. 1998. *Clays and Associated Minerals in Caves of the Guadalupe Mountains, New Mexico*. Dissertation.
- Polyak, Victor J., William C. McIntosh, Necip Guven, and Paula Provencio. 1998. *Age and Origin of Carlsbad Cavern and Related Caves from  $^{40}\text{Ar}/^{39}\text{Ar}$  of Alunite*. Science, Vol. 279, pgs. 1919-1922.
- Provencio, Paula and Victor Polyak. 1999. *Fossilized Bacteria in the Rusticle Stalactites of Lechuguilla Cave*. Abstract in 1999 NSS Program Guide.

- Provencio, Paula A. and Victor Polyak. 2001. *Iron Oxide-Rich Filaments: Possible Fossil Bacteria in Lechuguilla Cave, New Mexico*. Geomicrobiology Journal, Vol. 18, pgs. 297-309.
- Racine, Marty. 2000. *Life in a Cave: Trying to Unlock the Secrets of a Microbial World in Carlsbad Caverns National Park*. Texas-Houston Chronicle Magazine, pgs. 8-13.
- Rankey, Gene and Dan Lehrmann. *Geologists Measure Changes in Sea-level in Rocks Formed 260 Million Years Ago*. Research Report.
- Roemer, David. 2000. *Amphibians and Reptiles List for Carlsbad Caverns National Park, Eddy County, New Mexico*. Canyons & Caves No. 19, pgs. 12-15
- Roemer, David. 2000. *Bat Photomonitoring Update*. Canyons & Caves No. 17. pgs. 9-11.
- Roemer, David. 2001. *June 2001 Bat Photomonitoring Update*. Canyons & Caves No. 21. pgs. 3-5.
- Roemer, David. 2000. *Preliminary Survey of Wintering Sites of Mexican Free-tailed Bats from Carlsbad Cavern, New Mexico*. Canyons & Caves No. 16. pgs. 13-14.
- Roemer, David. 2000. *Recent Observations of Toads at Rattlesnake Springs*. Canyons & Caves No. 17. pgs. 13-14.
- Roemer, David. 2000. *A Tale of Two Nests: Spring 2000 Bell's Vireo Update*. Canyons & Caves. No. 17. pgs. 7-8.
- Route, William T., David H. Roemer, Val Hildreath-Werker, and Jim C. Werker, 1998. *Methods for Estimating Colony Size of Mexican Free-tailed Bats Roosting in Carlsbad Cavern*, Research Report.
- Spilde, Michael N., Penelope J. Boston, Diana E. Northup, Rachel T. Schelble, and Laura J. Crossey. 2002. *Subterranean Soil Development in Lechuguilla and Spider Caves, Carlsbad Caverns National Park, NM: Similarities to Desert Varnish and Surface Soils*. Research Report.
- Turin, H.J., and M.A. Plummer. 2000. *Lechuguilla Cave Pool Chemistry, 1986-1999*. Journal of Cave and Karst Studies, Vol. 62, No. 2, pgs. 135-143.
- Turin, H.J. 2000. *Carlsbad Cavern and Rattlesnake Spring, Carlsbad Caverns National Park Water Chemistry and Isotope Sampling, May 2000*. Research Report.
- Turin, H.J. 1995. *Tritium in Lechuguilla Cave Pool Water: Implications for Recharge Processes*. Geo2, Vol. 23, No. 1, pgs. 17-18.
- Ubick, Darrell and Thomas S. Briggs. 1992. *The Harvestman Family Phalangodidae. 3. Revision of Texella Goodnight and Goodnight (Opliones: Laniatories)*. Texas Memorial Museum, Speleological Monographs 3, pgs. 155-240.
- van der Heijde, Paul K.M., Kenneth E. Kolm, Helen Dawson, and Mark Brooke. 1997. *Determining Water Infiltration Routes from Structures Located Above Carlsbad*

*Cavern, Carlsbad Caverns National Park, Carlsbad, New Mexico.* Report to the National Park Service.

Welbourn, W. Calvin. 1992. *Preliminary Report on the Fauna Associated with Lint in Carlsbad Cavern, Carlsbad Caverns National Park, New Mexico.* Research Report.

West, Renée. 2002. *Pesticides and Carlsbad Caverns National Park.* Canyons & Caves No. 25. pgs. 7-9.

West, Steve. 1995. *Cave Swallow (Hirundo fulva), In The Birds of North America, No. 141 (A. Poole and F. Gill, eds.).* The Academy of Natural Sciences, Philadelphia, and The American Ornithologists' Union, Washington, D.C.