INSIDE EARTH

A NEWSLETTER OF THE NATIONAL PARK SERVICE
CAVE & KARST PROGRAMS
Edited by Dale L. Pate

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NATIONAL CAVE & KARST RESEARCH INSTITUTE

by Zelda Bailey

The pace of activities to establish the National Cave and Karst Research Institute (the Institute) has accelerated. Several articles have been published, including one in the April issue of *GSA Today*, and more are pending publication in journals and newsletters. Briefings have been done across the country, including staff of the Geological Society of America; the U.S. Geological Survey (USGS); the U.S. Forest Service (USFS); the Regional Executive Committee of the Southwest Strategy, which is made up of State and Regional Directors from numerous Federal and State agencies; a foundation president; Kentucky State Geologist and staff; Western Kentucky University staff; the National Speleological Society, the American Cave Conservation Association, and the Cave Research Foundation. An Institute web site will be accessible soon to help increase dissemination of information about the Institute to an even wider audience.

The Institute and the U.S. Geological Survey Ground Water Resources Program are sponsoring production of a USGS Circular (a magazine-style publication) on the topic of cave and karst science and management in the United States. The focus will be on what is being done within Federal agencies (with written contributions from those agencies) to avoid replication of what other groups already have written. This will be the first interagency Circular done by USGS.

The Institute and the Karst Waters Institute (KWI) are collaborating to produce a booklet entitled *Guidelines for Cave and Karst Management on America's Protected Lands*. KWI and the following federal agencies, the National Park Service, the Bureau of Land Management, the U.S. Fish & Wildlife Service (USFWS), and the USFS are providing authors, and the Institute and USFWS are funding the editing and printing.

New Mexico Tech (NMT), located in Socorro, New Mexico, was successful in their request to the New Mexico legislature for annual funding for activities in support of the Institute, which provides the Institute with the first non-Federal matching funds and the means to request Federal matching funds for initial operation of the Institute.

The Working Group for the Institute met for the second time, and contributed their energy and ideas to all the aspects of setting up the Institute, including staffing, funding, building design, research objectives, and special projects. A representative from Environmental Protection Agency has been added to the group.

PARK UPDATES

CARLSBAD CAVERNS NATIONAL PARK

by Dale Pate

(1) Popcorn broken from the Underground Concessions Area. (NPS Photo by Dale Pate)

Carlsbad Cavern Vandalism - Vandalism continues to be a problem in Carlsbad Cavern. Recent incidents have included: (1) A large piece of aragonite/calcite popcorn was broken in the Underground Concessions area. (2) At a point between the Boneyard and Big Room Junction, several large pieces of aragonite/calcite had been broken by someone climbing up a slope off the trail. Smaller pieces were also scattered in the same area. (3) Several large broken pieces of drapery were scattered along the floor of Jim White's Tunnel. A number of smaller pieces were scattered along the trail from the Doll's Theater to Jim White's Tunnel.

(2) Broken aragonite pieces recovered from area between the Boneyard and the Big Room. (NPS Photo by Stan Allison)

(3) Small pieces of broken drapery near Jim White's Tunnel in the Big Room. (NPS Photo by Tom Bemis)

A separate incident on June 9 occurred when two visitors were found hiding off the paved trail in the Queen's Chamber in possession of three freshly broken stalactites, drug paraphernalia and several grams of marijuana. The pair were charged with destruction of natural resources, being off the paved trail and entering a closed area, possession of a controlled substance and smoking in the cave. Nine mandatory-appearance violation notices were issued.

Lechuguilla Cave Culvert and Airlock Completed - This major project to provide a safer, more secure access to Lechuguilla Cave is now completed. Clean up and restoration of the entrance area is in progress. Thanks to all who worked on this project and special thanks to Jason Richards and Mark Bremer for making this project happen.

Paul Burger in the entrance to the airlock. (NPS Photo by Stan Allison)

Dye Tracing at Carlsbad Cavern - On May 10, Cave Resources personnel led by Paul Burger released 25,000 gallons of fluorescein dye into Bat Cave Draw, near the entrance to Carlsbad Cavern. A 1996 report found that

Waylon Cox, Stan Allison and Tilo Garcia mix freshwater with fluroescein dye that was then allowed to flow into Bat Cave Draw. (NPS Photo by Paul Burger)

there was heavy metal contamination in some of the pools of the cave and attributed it to runoff from the parking lots. This dye trace will give us a more direct correlation from runoff from the Bat Cave Parking area into various areas of Carlsbad Cavern. Trace levels of fluorescein were found in two cave samples before the dye was even released, good indication that automobile anti-freeze spills on the parking lot have been an ongoing contaminant problem in the cave.

George Wright Society Conference - At a special session of the George Wright Society Conference recently held in Denver, Dr. Larry Mallory and Dale Pate presented integrated talks on the value of microbes found in caves and how management of Lechuguilla Cave has been influenced by microbial research. The National Park Service is currently producing an Environmental Impact Statement that will address future microbial research within units of the NPS. Because of the large volume of ongoing microbial research at Yellowstone National Park, their resource management staff is the lead on producing this important document.

Bat Identification - On June 20 – 26, Dr. Lianne Ball and Matt Rahn were in the park to help us develop an echolocation library of vocalizations of bats found in the park using an ANABAT bat detector. They will be conducting an acoustical survey of some backcountry caves and helping us develop a monitoring program to determine important landscape features for protecting all of our bat species.

Welcome To New Chief - Congratulations and welcome to Chuck Barat who was recently selected as the new Chief for the Resources Stewardship & Science Division. Chuck comes from Lava Beds National Monument in northern California where he was the Chief of Resource Management.

Chuck Barat, the new Chief of the Resources Stewardship & Science Division at Carlsbad Caverns National Park.
(NPS Photo by Dale Pate)

LAVA BEDS NATIONAL MONUMENT

by Matt Reece

Quite a bit has been happening at Lava Beds since our last Inside Earth update. There are currently 436 known caves in the park, with a combined length of approximately 27.32 miles. The cave recon project has slowed a bit while the efforts of the staff have been shifted in other directions.

New VC - One of the largest tasks for all of the park staff lately has been work on the new Visitor Center (VC) Complex. The current VC Complex consists of four buildings (Interpretation/Protection offices, restrooms, collections/A/V storage, and the VC itself) and a small parking lot surrounding Mushpot Cave. These buildings are all in some state of disrepair, and are inadequate for the current visitation patterns. Additionally, all of this development is directly above caves. The new VC Complex is located near the present VC, and will be away from any known caves. Some geophysical testing has been done to determine other areas to avoid due to potential caves. This project, once completed, will not only have an incredible benefit to the caves, but to the visitor experience as well.

Research Center - Thanks to the dedication of the Cave Research Foundation (CRF) and the Lava Beds Natural History Association, the fundraising goal for the construction of the Lava Beds Research Center has been met (but… you can still send money!) This facility will be used to support research in the Monument by providing housing, laboratory, and storage space for researchers. It will also be used as a base of operations for CRF projects at Lava Beds. For more info see: http://www.pwpconsult.com/lbrc.site/

Cave Management Plan Update - We've begun the daunting task of a much-needed update of the Monument's Cave Management Plan. The current plan is from 1990 and is outdated and lacks direction on a number of important issues. We hope to have the plan available for public review by late winter/early spring.

Rock Art Conservation - With special funding, we have been able to enlist the expertise and talents of Chris Roundtree to implement measures to preserve some of the prehistoric rock art in the Monument. Chris has been conducting a great deal of research on the origin of the art, as well as figuring out how to best preserve and interpret some of the more significant rock art sites. Chris has also completed the photodocumentation of the historic rock art in the park – mostly paintings from the 1930's by the likes of JD Howard and Walter Glaeser.

CCC Trail Restoration - Another specially funded project this year has been the restoration of CCC-era trails in the developed caves. John Vargo (possibly the first badge-wearing deaf NPS employee) has done an outstanding job of restoring and rehabilitating these trails. John's work not only makes the trails safer for visitors, but it also does a great job at reducing visitor impact in the more highly used caves by keeping the majority of the visitors on the trail. John is a veteran of the Mammoth Cave Restoration Field Camp, and has spearheaded and participated in a number of other restoration projects across the country.

Before trail restoration in Hopkins Chocolate Cave.
(NPS Photo by John Vargo)

After trail restoration in Hopkins Chocolate Cave.
(NPS Photo by John Vargo)

Cave Inventory - Cave inventory is moving right along at Lava Beds – I've recently converted the old dBase III databases into a streamlined MS Access system, similar to the one I designed for Wind Cave. We're attempting to round up years worth of lost survey notes to complete the cave files. Many of them have been lost for good, but we're making a dent in the missing data. The numbering, monumenting, and locating by using Global Positioning Systems of caves is still an ongoing project, and we're beginning to see the light at the end of the tunnel! Bernard Stoffel has put quite a bit of work into the Monument's Geographic Information System (GIS), and has developed a nice GIS of the Monument's caves. We've recently received a conservation grant from ESRI for 3-D Analyst, and plan to do some 3-D modeling of lava tube systems as soon as we get the survey data entered.

Monitoring - We are continuing to monitor ice levels in the Monument's ice caves. The ice floor in Merrill Cave is rapidly retreating, and the cave has been closed except for guided tours during the summer months.

Photo on the left was taken in 1991 showing extent of ice in Merrill Ice Cave. Photo on the right was taken in 2000 documenting loss of ice. (NPS Photos)

Our bat-monitoring program is also in full swing. Initial results of the *Corynorhinus* outflight counts show a stable population trend. We've managed to keep tabs on the ladies quite well this summer. The results aren't in on the *Tadarida* colony, but the visual estimation still says there's a bunch of bats out there.

CRF Projects - The Cave Research Foundation has remained active at Lava Beds with successful Memorial Day and Labor Day expeditions. In addition, project leader Bill Deveraux has been making trips every other weekend to support the cave management program. The main CRF projects currently involve survey/exploration, monumenting, ice level monitoring, and cave entrance photography.

MAMMOTH CAVE NATIONAL PARK

by Rick Olson

During the week of November 12-19, 2000 Rick Olson visited Hungary with George Mahaffey of the National Park Service (NPS) International Affairs Office. Three national parks in Hungary were visited: Aggtelek,

Hortobagy, and Balaton Uplands. Division of Nature Conservation leaders within the Ministry for Environment would like to establish sister park relationships between these three Hungarian parks and U.S. National Parks. A recently signed agreement between the US and Hungarian park systems makes this possible. Aggtelek and Balaton Uplands National Parks have extensive karst resources, largely rural agrarian cultures, and therefore have some of the same problems we encounter in the U.S.

Subsequently, several NPS units (Carlsbad, Wind, Jewel, Mammoth) were visited by the Superintendent and Interpretation Director from Aggtelek National Park, and the Director of the Speleological Institute of Hungary. They visited Mammoth Cave National Park during May 23-25. Extensive discussions were held with Superintendent Switzer and staff on programs for working with gateway communities, managing endangered bat habitat, cave/karst GIS, exotic plants, fire, visitor use, and Environmental Education. Many thanks to Dave Krewson of NPS International Affairs for making this visit possible.

The project titled "Restore Habitat for Federally Endangered Indiana Bats (Myotis sodalis) in Mammoth Cave" has been funded for FY '02 and '03. Ranked number 2 of 99, this $245,000 project will restore airflow through Little Bat Avenue, and in addition to habitat restoration it is hoped that condensation dripping on War of 1812 saltpeter leaching vats at Booth's Amphitheater will be reduced or even eliminated.

During the week of 16-20 July, Jim Kennedy of Bat Conservation International visited in order to put temperature data loggers in bat hibernacula. In all, 19 loggers were installed in Historic Mammoth, Long, Dixon, and Wilson Caves. They will run for the entire year, and so avoids any disturbance to the bats during the hibernation season from people downloading data.

A new educational booklet titled "Living With Karst, A Fragile Foundation" has been published by the American Geological Institute. Rick is one of the contributing authors, and "Don't Mess With Mammoth Days" is used as an example of cooperative ecosystem management with emphasis on habitat restoration for the endangered Kentucky Cave Shrimp. The NPS contributed $10,000 (as did many other agencies and organizations) toward publication costs. The booklet also won an award at the International Congress of Speleology this summer in Brazil.

SEQUOIA AND KINGS CANYON NATIONAL PARKS

by Joel Despain

The Cave Management Program at Sequoia and Kings Canyon National Parks has been assisted this year by Shane Fryer, an enthusiastic caver and ArcView wiz. With Shane's help we have been tackling a number of projects. This includes preparing a paper using Geographic Information Systems (GIS) for in-cave management decisions for the Journal of Cave and Karst Studies special issue on cave GIS. A dye trace project has also been planned for the remote Cave Creek area of the parks. This will be conducted at low flow this fall and repeated at higher flow next spring. Several new databases have recently been generated including biological inventory and caver visitation data sets. The park will be hosting visiting Cave Specialist Stan Allison from Carlsbad Caverns National Park for 10 days at the end of August. Stan will be traveling to the parks on an Albright-Wirth grant and will participate in cave management, Cave Research Foundation and park activities while at the park. A Crystal Cave Restoration Weekend will be held this year on October 27 and 28 and will feature hose washing of upper levels of the cave.

The Cave Management Program will be hosting a safety review session on August 30. The session will include park rangers, local cavers, and visiting cave specialists in an organized discussion on safe caving issues, ideas, and procedures. Topics will include above ground (off-trail) safety, in-cave safety, and cave SAR. Presenters include Cindy Heazlit, Brian Lavendar and Joel Despain.

The Cave Research Foundation has had a busy summer in Redwood Canyon at Lilburn Cave. More unexplored passage has been discovered this year than in any other year in the past five. Surveyors have been hard at work documenting these previously unknown areas of the cave. Other CRF projects this summer include restoration work in Lilburn and the continuing survey and inventory of caves in the Mineral King area of the parks.

WIND CAVE NATIONAL PARK

by Rod Horrocks

This year's Wind Cave Restoration Camp was held on May 10-11, 2001. Working along the Natural Entrance Tour route, the crew of 12 workers removed a total of 3,943 pounds of trail construction debris and lint from the west side of the Model Room. In one corner of the room, they discovered a cache of nine turn-of-the century flash powder bottles with intact corks and labels buried underneath a large breakdown block. Since that two-day camp, we have continued the restoration project with the

help of the park's Trail Crew. Thus far, we have removed nearly a ton of wood and asphalt from the cave. Much of this is rotten wood that collapsed from the elevator shaft forms built in 1939.

Noah Daniels, a 1996 intern from Jewel Cave National Monument, recently finished his Masters thesis and took a seasonal job as our summer Cave Management Technician. He has started a project in Wind Cave to recreate and refine Herb Conn's mid 1960's barometric air volume study. This time around, we will be taking into account the Snake Pit entrance and associated blowholes.

Dr. Jake Turin and two of his students spent a week at Wind Cave collecting water samples for a stable isotope study looking for tritium and chlorine-36. This project is being conducted jointly with a project at Lechuguilla Cave at Carlsbad Caverns National Park.

Dr. John Moore, from the University of Northern Colorado, is continuing his research on the impacts of humans on the cave biota in Wind Cave. Thus far he has documented two species of cave-adapted collembola, raising the total numbers reported from the cave to three. He as also learned several interesting things about the classifications of organisms (tropic structure) of Wind Cave's biotic community.

We have recently experienced a major fish kill of brook trout in Highland Creek, a stream that sinks within the park. This stream feeds the Madison aquifer, but it is unknown if it reaches Wind Cave. The cave management staff is assisting the Park's resource management staff in attempting to determine the cause of this die-off.

The drop in "What the Hell" lake, which sumps the route to the Lakes and the deep point in the cave, has significantly slowed down, probably as a result of the extremely wet summer we have had. This lake would have to drop an additional foot and a half to once again allow access to that section of the cave.

Since the last issue of Inside Earth, the surveyed length of Wind Cave has been increased by 2.29 miles, raising it to 100.28 miles. Wind Cave passed the 100-mile mark on August 11, 2001 and was the seventh cave in the world to reach that milestone. On the same day, Wind Cave passed Fisher Ridge Cave (100.03 miles) to become the sixth longest cave in the world.

We have set October 13 for the official Wind Cave 100-Mile celebration party. Anyone that has participated in the Wind Cave survey is invited to attend. This event will consist of three talks and accompanying slide shows from three key explorers. If you are interested in attending the event, contact Marc Ohms at Marc_Ohms@nps.gov (RSVP by September 21, 2001 for the catered buffet dinner).

ARTICLES

POST-FIRE FLOODING AT JEWEL CAVE

by Rene Ohms and Mike Wiles

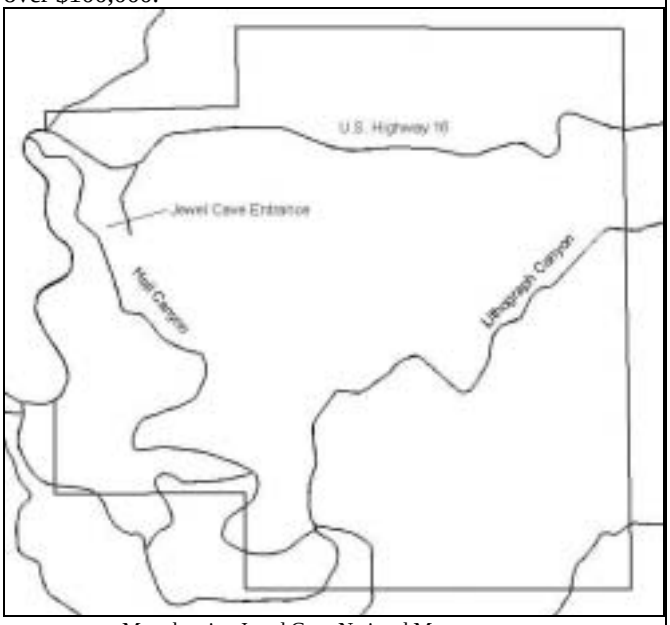
The Jasper Fire of August 2000 burned over 83,000 acres in the Black Hills and 90% of Jewel Cave National Monument. The lack of tree cover following the fire has decreased evapotranspiration, increasing surface runoff. Over the weekend of July 7 and July 8, 2001, two inches of rain fell in two 45-minute events, causing significant flash flooding in Hell Canyon and Lithograph Canyon.

The Jasper Fire approaches the Jewel Cave Visitor Center, August 2000. (NPS Photo by Marc Ohms)

There are no historical records of Lithograph Canyon ever carrying water, and prior to 1995, no portion of Hell Canyon

had carried water for over 60 years. Since 1995, a small stream has flowed perennially in Hell Canyon north of the monument, and has flowed into the monument twice. Between April 2001 and the flood event, however, Hell Canyon Stream had been completely dry.

During the flood, drainages north of Highway 16 swelled with up to 15 feet of water, and debris carried by this water plugged culverts near the road. Two feet of water flowed across the highway, blocking traffic. Hell Canyon Stream flowed south into the monument, then continued to flow beyond the monument's southern boundary. Debris comprised of large boulders and logs was washed into the canyon by the flooding, and water lines indicate that a stream nearly 100 feet wide ran through south Hell Canyon below the Jewel Cave entrance on Sunday, July 8. Several parts of Lithograph Canyon Road have been washed out, rendering the road impassible. A telephone repeater was washed out, and buried telephone lines were exposed. Damage to Lithograph Canyon Road is estimated at well over $100,000.



Map showing Jewel Cave National Monument.

What does this mean for the cave? We expect to see increased infiltration rates and therefore, more water entering the cave. Several new pools have been recorded in Hell's Half Acre, a cave passage approximately 125 feet below Hell Canyon. Dye from Hell Canyon Stream was recovered at High Water, an underground pool just east of the canyon, in 1997. Flooding that same year also produced new pools in Hell's Half Acre and sumped the VISC, a passage leading to the western side of the cave. The full hydrologic effects of the fire may not be known for years, as we continue to monitor surface stream flow, record new cave pools, and measure in-cave drip rates.

Laws, Policies & Regulations

2001 NPS MANAGEMENT POLICIES

Referencing Caves

(Compiled by Ronal C. Kerbo from the newly revised and published NPS Management Policies. Available on the Internet at http://www.nps.gov/refdesk/mp/index.html)

Chapter 1: The Foundation

1.7.3 Information Confidentiality

While it is the general policy of the NPS to share information widely, the Service also realizes that providing information about the location of park resources may sometimes place those resources at risk of harm, theft, or destruction. This can occur, for example, with regard to **caves**, archeological sites, and rare plant and animal species. Some types of personnel and law enforcement matters are other examples of information that may be inappropriate for release to the public. Therefore, information will be withheld when the Service foresees that disclosure would be harmful to an interest protected by an exemption under the Freedom of Information Act (FOIA).

Information will also be withheld when the NPS has entered into a written agreement (e. g., deed of gift, interview release, or similar written contract) to withhold data for a fixed period of time at the time of acquisition of the information. Such information will not be provided unless required by FOIA or other applicable law, a subpoena, a court order, or a federal audit.

NPS managers will use these exemptions sparingly, and only to the extent allowed by law. In general, if information is withheld from one requesting party, it must be withheld from anyone else who requests it, and if information is provided to one requesting party, it must be provided to anyone else who requests it. Procedures contained in Director's Order #66: FOIA and Protected Resource Information, will be followed to document any decisions to release information or to withhold information from the public.

(See Natural Resources Information 4.1.3; Studies and Collections 4.2; Caves 4.8.2.2; Research 5.1; Confidentiality 5.2.3; Interpretation and Education Services Beyond Park Boundaries 7.5.2. Also see Director's Orders #5: Paper and Electronic Communications, #19: Records Management, #84: NPS Library Programs, and #70: Internet and Intranet Publishing. Also see Reference Manual 53, Chapter 5)

Chapter 4: Natural Resource Management

The National Park Service will preserve the natural resources, processes, systems, and values of units of the national park system in an unimpaired condition, to perpetuate their inherent integrity and to provide present and future generations with the opportunity to enjoy them. The National Park Service will strive to understand, maintain, restore, and protect the inherent integrity of the natural resources, processes, systems, and values of the parks. The Service recognizes that natural processes and species are evolving, and will allow this evolution to continue, minimally influenced by human actions. The natural resources, processes, systems, and values that the Service preserves are described generally in the 1916 NPS Organic Act and in the enabling legislation or Presidential proclamation establishing each park. They are described in greater detail in management plans specific to each park. Natural resources, processes, systems, and values found in parks include:

- Physical resources such as water, air, soils, topographic features, geologic features, paleontological resources, natural soundscapes, and clear skies;
- Physical processes such as weather, erosion, **cave formation**, and wildland fire;
- Biological resources such as native plants, animals, and communities;
- Biological processes such as photosynthesis, succession, and evolution;
- Ecosystems; and
- Highly valued associated characteristics such as scenic views.

4.8.1.2 Karst

The Service will manage karst terrain to maintain the inherent integrity of its water quality, spring flow, drainage patterns, and caves. Karst processes (the processes by which water dissolves soluble rock such as limestone) create areas typified by sinkholes, underground streams, caves, and springs.

Local and regional hydrological systems resulting from karst processes can be directly influenced by surface land use practices. If existing or proposed developments do or will significantly alter or adversely impact karst processes, these impacts will be mitigated. Where practicable, these developments will be placed where they will not have an effect on the karst system.

4.8.2 Management of Geologic Features

The Service will protect geologic features from the adverse effects of human activity, while allowing natural processes to continue. The term "geologic features" describes the products and physical components of geologic processes. Examples of geologic features in parks include rocks, soils, and minerals; geysers and hot springs in geothermal systems; **cave and karst systems**; canyons and arches in erosional landscapes; sand dunes, moraines, and terraces in depositional landscapes; dramatic or unusual rock outcrops and formations; and paleontological and paleoecological resources such as fossilized plants or animals, or their traces.

4.8.2.2 Caves

As used here, the term "caves" includes karst (such as limestone and gypsum caves) and non- karst caves (such as lava tubes, littoral caves, and talus caves). The Service will manage caves in accordance with approved cave management plans to perpetuate the natural systems associated with the caves, such as karst and other drainage patterns, air flows, mineral deposition, and plant and animal communities. Wilderness and cultural resources and values will also be protected.

No developments or uses, including those that allow for general public entry, such as pathways, lighting, and elevator shafts, will be allowed in, above, or adjacent to caves until it can be demonstrated that they will not unacceptably impact natural cave conditions, including sub- surface water movements. Developments already in place above caves will be removed if they are impairing or threatening to impair natural conditions or resources.
Parks will strive to close caves or portions of caves to public use, or to control such use, when such actions are required for the protection of cave resources or for human safety. Some caves or portions of caves may be managed exclusively for research, with access limited to permitted research personnel. All recreational use of undeveloped caves will be governed by a permit system. "Significant" caves will be identified using the criteria established in the 43 CFR Part 37 regulations for the Federal Cave Resources Protection Act of 1988 (FCRPA). As further established by the FCRPA, specific locations of significant cave entrances may be kept confidential and exempted from FOIA requests.
(See Decision- making Requirements to Avoid Impairments 1.4.7; Information Confidentiality 1.7.3; Caves 6.3.11.2)

4.10 Lightscape Management

The Service will preserve, to the greatest extent possible, the natural lightscapes of parks, which are natural resources and values that exist in the absence of human-caused light. **The absence of light in caves and at the bottom of deep bodies of water influences biological processes and the evolution of species---.** The phosphorescence of waves on dark nights help hatchling sea turtles orient to the ocean. The stars, planets, and

earth's moon that are visible during clear nights influence humans and many other species of animals, such as birds that navigate by the stars or prey animals that reduce their activities during moonlit nights.

Recognizing the roles that light and dark periods and darkness play in natural resource processes and the evolution of species, the Service will protect natural darkness and other components of the natural lightscape in parks. To prevent the loss of dark conditions and of natural night skies, the Service will seek the cooperation of park visitors, neighbors, and local government agencies to prevent or minimize the intrusion of artificial light into the night scene of the ecosystems of parks. The Service will not use artificial lighting in areas such as sea turtle nesting locations, where the presence of the artificial lighting will disrupt dark- dependent natural resource components of a park.

The Service will:

- Restrict the use of artificial lighting in parks to those areas where security, basic human safety, and specific cultural resource requirements must be met;
- Utilize minimal impact lighting techniques; and
- Shield the use of artificial lighting where necessary to prevent the disruption of the night sky, **natural cave processes,** physiological processes of living organisms, and similar natural processes.

The decision about whether or not to install artificial lighting in particular circumstances is left to the discretion of the superintendent, and is made through the planning process.

(See Visitor Safety and Emergency Response 8.2.5, Facility Planning and Design 9.1.1; Integration of Facilities into the Park Environment 9.1.1.2; Energy Management 9.1.7)

Chapter 6: Wilderness Preservation and Management

6.3.11.2 Caves

All cave passages located totally within the surface wilderness boundary will be managed as wilderness. Caves that have entrances within wilderness but contain passages that may extend outside the surface wilderness boundary will be managed as wilderness. Caves that may have multiple entrances located both within and exterior to the surface wilderness boundary will be managed consistent with the surface boundary; those portions of the cave within the wilderness boundary will be managed as wilderness.

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