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Caves and Karst of the National Park Service

by David A. Ek

Abstract

With such famous caves such as Wind, Jewel, Carlsbad, and Mammoth, the public has long associated caves with the National Park Service (NPS). However, the diversity of "lesser-known" caves within the NPS is also quite high. Of the 282 NPS sites that contain significant natural resources, 84 contain caves and an additional 43 contain karst. This makes caves and karst one of the more dominant ecosystems/habitats/ resource types within the entire National Park System.

Seven of the eight cave types are represented, including several that may be considered the "type specimen". Managers, when evaluating potential impacts to caves, should evaluate both the individual resources within the particular cave but also the cave's relationship to the regional and national environment.

Karst and cave processes are not allows easily recognizable. For instance, although no soluble rocks are exposed, karst processes are likely to play a significant role in the one of the primary resource threats affecting Oklahoma's Chickasaw National Recreation Area. For many years, researchers have investigated the park's springs to determine their characteristics and to explain their slow disappearance. These researchers employed traditional groundwater investigative techniques, only to find conflicting and inconclusive results. However, many traditional groundwater techniques do not work well in karst terrains. Karst research at Chickasaw NRA may lead to a better understanding of the springs and the cause of the impacts to these significant park resources. This is but one example highlighting the importance of an inventory of cave and karst resources within the National Park Service.

Introduction

There are 388 units of the National Park Service (NPS), as of December 2005. There is at least one NPS unit located in every state within the United States, except Delaware. Of these, 282 (73 percent) are considered to contain significant natural resources. Additionally, there are NPS sites in Guam, Puerto Rico, the Virgin Islands, and American Samoa. This represents a diverse array of parks and associated ecosystems.

There are also diverse caves within the NPS. With such famous caves such as Wind, Jewel, Carlsbad, and Mammoth, the public has long associated caves with the NPS. However, the diversity of "lesser-known" caves within the NPS is also quite high. Of the 282 NPS sites that contain significant natural resources, 84 contain caves and an additional 43 contain karst. Therefore, a total of 45 percent of all NPS sites containing significant natural resources contain caves and/or karst. This makes caves and karst one of the more dominant ecosystems/habitats/resource types within the entire National Park System.

Definitions

Cave- the Federal Cave Resources Protection Act defines a cave as "any naturally occurring void, cavity, recess, or system of interconnected passages beneath the surface of the earth or within a cliff or ledge, including any cave resource therein, and which is large enough to permit a person to enter, whether the entrance is excavated or naturally formed". For the purpose of this paper, the term "cave" is less inclusive. Caves are reserved for only those features meeting the above definition and having a sufficient length-to-entrance width ratio whereas the cave's environment is noticeably altered/modified. This ecological component was included to eliminate the many rockshelters, overhangs and other small recesses that have no real "cave climate" or "cave ecology". With this more restricted definition, caves must have sufficient length so that the humidity, temperature, ambient light and other environmental factors differentiate it from surface environments. This is of course subjective, however two generalizations can often be made: the cave must reach a point of near or total darkness, and if a suspected "cave" contains organisms that are known to be cave-, or partially cave, adapted organisms, it probably is a "cave". With such a definition, this list does not include parks, such as Canyon de Chelly National Monument or Chattahoochee River National Recreation Area, that contain features called 'caves', but do not fit the definition of caves used in this paper. Although many of these cave-like features would fit under the broader definition of a cave as defined by the Federal Cave Resources Protection Act, these features do not serve the ecological role that a "true" cave does. These features may be more properly called "rockshelters". Additionally, since the broader definition has no clear minimum bounds or standard, the reporting of the number of caves within any park would be nearly impossible. If one were to include rockshelters, the number of parks containing caves and the total number of caves within National Park System would dramatically increase.

Karst- for the purposes of this paper, surface morphological features such as sinkholes, sinking streams, etc., are not used as a definitions of karst, aspects that are more functional are utilized. Quinlan, et al. (1991) defines a karst aquifer as "an aquifer in which flow of water is or can be appreciable through one or more of the following: joints, faults, bedding planes, and cavities-- any or all of which have been enlarged by dissolution of bedrock". In his investigation, Quinlan found that dye injected in nearly any carbonate rock experienced non-Darcian flow typical of karst aquifers, even those carbonate rocks that did not contain any outward appearances of being karst. Due to these findings, karst is defined as any carbonate, sulfate or other rock capable of relatively

rapid dissolution by water under naturally occurring pH ranges. No attempt was made to define the minimum thickness of rock necessary to be considered karst. However, minor in-fillings and veins were not included.

Discussion

In the discussion of which parks contain karst, one must also consider the vertical location of the karst. For instance, some definitions would only include rocks exposed on the surface. However, for the purposes of this paper a broader interpretation is used- it is included if the karst rock unit is shallow enough to enable it to interact with surface or groundwater. The inclusion of buried rock units, where there are no surface exposures, was due to four reasons:

(1) land management within the National Park Service is inclusive of a vertical column extending from the atmosphere above the surface portion of the park down through towards the center of the earth;

(2) just because a rock unit is not exposed does not mean that these rocks are not having an effect upon surface and subsurface processes. For instance, non-soluble rocks overlie a significant portion of Mammoth Cave, the longest known cave in the world. However, undeniably, the underlying cave is having an effect upon surface and subsurface water.

(3) if there are surface or subsurface processes occurring that are affected by covered karst, then there is a possibility that land managers could unknowingly alter, modify or interrupt these processes out of ignorance.

(4) it is a natural process within a National Park Service unit, and the National Park Service has been directed to manage natural processes.

The following list summarizes the parks that contain caves or karst. This is a dynamic list, due to at least eight reasons:

(1) many NPS areas have not been adequately inventoried for cave and karst resources;

(2) some NPS managers consider caves as a relatively minor resource within the NPS, therefore, adequate attention may not have been placed upon caves or karst;

(3) many people knowledgeable about the presence of caves closely guard these secrets;

(4) historically, caves were viewed more as recreational resources, and less so as natural laboratories for scientific research, therefore, the quantity of published references and research within NPS caves is often sparse;

(5) cave and karst processes are often not as well understood by NPS managers compared with many other park resources and processes, so therefore, park management's ability to recognize cave and karst processes is hampered;

(6) caves are still being discovered;

(7) since some cave types are formed by rapid processes, new caves, such as lava caves, have formed since parks have been established;

(8) people's definition of a cave varies, so that the number of caves within an area varies depending upon the source.

The references included in the following list (Table 1) are not intended to be a complete list, quite the contrary. The listed references were included to provide examples of some of the sources that author used to confirm the presence of caves or karst on NPS lands. The many references used to confirm which parks do not containing caves or karst has not been listed. The author attempted not to rely on only one source of information, but rather obtained a selection of collaborating material, such as personal interviews. Occasionally, sources conflicted. In these situations, the author evaluated and judged the validity of data and the most reliable information was presented.

The author has been maintaining an inventory of NPS areas containing caves and karst for a number of years. Such an inventory is never "complete." Therefore, the author would appreciate any additions or corrections.

Table 1. NATIONAL PARK SERVICE CAVES / KARST

Cave Sites

Park	Cave Type	# Caves	References
Abraham Lincoln Birthplace National Historic Site	(Ls)	001	45
Acadia National Park	(Er)	012	116,129
Amistad National Recreation Area	(Ls)	030	93,105,225
Aniakchak National Monument **or** Preserve	(La)	001	PV
Apostle Islands National Lakeshore	(Er)	075	153
Badlands National Park[1,2]	(Er)	050	25,30,72,80
Bandelier National Monument	(La)	002	45,49,50,201
Bering Land Bridge National Preserve	(La,Er)	113	73,130
Big Bend National Park	(Ls)	007	35,72,117,134
Big South Fork National River and Recreation Area	(Ls)	001	37
Bighorn Canyon National Recreation Area[3]	(Ls)	001	19,78,106
Bryce Canyon National Park	(Ls)	001	36,63,64,72,167,215
Buffalo National River	(Ls)	275	11,45,81,152
Carlsbad Caverns National Park	(Ls)	109	9,45,72,76,77,84,85,133a,163
Catoctin Mountain National Park	(Te)	002	54
Cedar Breaks National Monument	(Ls)	001	72,120
Channel Islands National Park	(Er)	369	PV
Chesapeake and Ohio Canal National Historical Park	(Ls)	011	54,83,141
Chickamauga & Chattanooga National Military Park	(Ls)	014	45,102
Coronado National Memorial	(Ls)	009	2,150
Crater Lake National Park	(Er)	051	4,103
Craters of the Moon National Monument	(La)	130	23,30,193
Cumberland Gap National Historical Park	(Ls)	015	45,107
Death Valley National Park	(Ls)	002	21,24,27a,45,72,207
Denali National Park	(Ls,Gl)	003	59,72
Dinosaur National Monument	(Ls,Er)	005	30,46a,68,74a,94,115,165,212,213
El Malpais National Monument	(La)	240	45,148,157,187
Fort Donelson National Battlefield	(Ls)	001	PV
Gates of the Arctic National Park	(Ls)	007	72,198
Gila Cliff Dwelling National Monument	(Er)	001	29
Glacier National Park	(Ls)	006	19,20,30,42,43,72,122,175
Glacier Bay National Park	(Gl,Ls)	002	72,220
Golden Gate National Recreational Area	(Er)	119	173
Golden Spike National Historic Site[4]	(Ls)	004	80,224
Grand Canyon National Park	(Ls)	400	72,92,138,171
Grand Teton National Park	(Ls)	017	30,56,72,78,120
Great Basin National Park	(Ls)	042	45,72,80,133a,222a
Great Smoky Mountains National Park	(Ls)	010	3,45,60,72,127,143,154,156,182,223
Guadalupe Mountains National Park	(Ls)	025	45,72,76,76,84,85,86,147
Haleakala National Park	(La)	024	128
Harpers Ferry National Historical Park[3]	(Ls)	002	33,45,75,89
Hawaii Volcanoes National Park	(La)	155	18,39,61,62,90,144,166
Jewel Cave National Monument	(Ls)	012	30,45,46,53,72,161,222
Kalaupapa National Historical Park	(La)	016	69,185

Park (con't.)	Cave Type	# Caves	References
Kaloko-Honokohau National Historical Park	(La)	004	18
Kenai Fjords National Park	(Er)	012	72,205
Kings Canyon National Park	(Ls)	012	38,72
Lake Mead National Recreation Area	(Ls)	002	16,172,208, 210
Lava Beds National Monument	(La)	399	5,57,67,104,121,149,178,190,217
Mammoth Cave National Park	(Ls)	350	45,45a,72,162
Mojave National Park	(Ls,La)	010	1,109,218
Montezuma Castle National Monument	(Ls)	001	146
Mount Rainier National Park	(Gl)	005	6,28,41,45,70,119,188
Natchez Trace Parkway	(Ls)	005	139,197
Noatak National Preserve	(Ls)	004	183
Obed Wild and Scenic River	(Er)	001	204
Olympic National Park	(Er)	003	26,45,70,119,202
Oregon Caves National Monument	(Ls)	012	45,95a,96,135,136,177
Ozark National Scenic Riverways	(Ls)	320	14,45,160
Parashant National Monument	(Ls)	035	45,171
Pea Ridge National Military Park	(Ls)	001	11,195
Pinnacles National Monument	(Te)	006	45,48,140,151
Point Reyes National Seashore	(Er)	139	173
Pu'uhonua o Honaunau National Historical Park	(La)	006	18
Redwood National and State Parks[2]	(Er)	002	72,192
Rocky Mountain National Park[5]	(Gl)	001	30,45,159
Russell Cave National Monument	(Ls)	010	45,65,87
Saint Croix National Scenic Riverway	(Er)	012	47
San Juan Island National Historic Site	(Ls)	001	32,45,70,119
Sequoia National Park	(Ls)	188	38,72
Shenandoah National Park	(Ls)	001	12
Stones River National Battlefield[4]	(Ls)	001	45,137
Sunset Crater Volcano National Monument	(La)	001	10,189
Theodore Roosevelt National Park[1]	(Er)	006	30,45,100,179
Timpanogas Cave National Monument	(Ls)	006	30,45,80
Valley Forge National Historical Park	(Ls)	005	45,101,145,196,226
War in the Pacific National Historical Park	(La)	012	40
Wilson's Creek National Battlefield	(Ls)	002	11
Wind Cave National Park	(Ls)	042	30,45,46,53,72,80,125,133a,161
Wrangell-St. Elias National Park	(Ls,Gl)	004	7,58,72,114,123,174,181
Wrangell-St. Elias National Preserve	(Ls)	004	7,58,72,114,123,174,181
Wupatki National Monument	(Er)	012	164,180
Yellowstone National Park	(Ls,La)	006	45,72,78,124
Yosemite National Park	(Te/Ls)	011	45,72,82,173
Yukon-Charley Rivers National Preserve	(Ls)	006	176,198

Karst Areas With No Known Caves

Park	References
Agate Fossil Beds National Monument	30
Alibates Flint Quarries National Monument	13,45,133,169,216
Antietam National Battlefield	219
Arches National Park	72
Big Cypress National Preserve	91,108,131
Biscayne National Park	31,72,97,110
Bluestone National Scenic River	194
Buck Island Reef National Monument	72,132
Canaveral National Seashore[#]	52,199,200
Canyonlands National Park	72
Capitol Reef National Park	72
Castillo De San Marcos National Monument[6]	191
Chickasaw National Recreation Area	22,45,71,203,209,221
Colonial National Historical Park	170
Cumberland Island National Seashore[6]	55,66
De Soto National Memorial[6]	8,206
Delaware Water Gap National Recreation Area	186
Devils Tower National Monument[2]	30,45
Dry Tortugas National Park[7]	72,132,184
Everglades National Park	15,27,72,88,111,211,214
Fort Caroline National Memorial[6]	17,191
Fort Frederica National Monument[6]	PV
Fort Matanzas National Monument[6]	191

Park (cont.)	References
Fort Pulaski National Monument[6]	PV
Fort Sumter National Monument[6]	PV
Fossil Butte National Monument	30,118
Gates of the Arctic National Preserve	72,198
Katmai National Park or Preserve	72
Lake Clark National Park	72
Lake Meredith National Recreation Area	13,45,133,169,216
Lyndon B. Johnson National Historical Park[6]	98, PV
National Park of American Somoa[7]	72,132
New River Gorge National River	194
Ross Lake National Recreation Area[2]	45,74,119
Saguaro National Park	72,95
Salinas National Monument	29
Salt River Bay Nat'l. Hist. Park & Ecological Preserve[7]	72,132
Timucuan Ecological and Historic Preserve[6]	17,142
Tonto National Monument	79
Tuzigoot National Monument	146
Virgin Islands National Park[7]	45,72,132
Zion National Park	44,72

TOTAL	**85 parks containing caves, with a total of 4,032 caves (2,030 solution caves & 2,002 non-solution caves)**
TOTAL	**95 parks containing karst**
TOTAL	**42 parks containing karst, however with no known caves**
TOTAL	**32 parks containing caves without having any karst with a total of 1,970 caves**

THERE ARE 128 NATIONAL PARK SERVICE UNITS CONTAINING CAVES OR KARST

KEY:

Ls-	Solution Caves	La-	Lava Tubes/Lava Caves
Gl-	Ices Cave (caves in summit ice caps or glaciers)	Ta-	Talus Caves
Te-	Tectonic Caves	Er-	Erosion Caves

1	= Small cave like erosion features, may be too small to be called a "cave", however contains bats.
2	= Very minor or very thin lens of soluble rocks
3	= Cave is within the park but the entrance is located outside park boundaries
4	= Contains cave-like karst features but unknown how long, may not be an actual cave
5	= May no longer be present due to glacial melting.
6	= Buried karst- no karst feature visible on surface
7	= Carbonate rocks consists of active or recent coral reefs
PV	= Partially verified at time of press due to misplaced or incomplete reference.

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