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MAMMOTH CAVE NATIONAL PARK KENTUCKY, UNITED STATES OF AMERICA

Mammoth Cave National Park, in the state of Kentucky, is a karst limestone landscape with the world's longest and most faunistically diverse network of caves and underground passageways. The Park and its subterranean labyrinth of more than 550 surveyed kilometers of passageways host an unusual flora and fauna, including a large number of endangered cave-dependent species.

COUNTRY United States of America - Kentucky

NAME Mammoth Cave National Park

NATURAL WORLD HERITAGE SITE

1981: Inscribed on the World Heritage List under Natural Criteria vii, viii and x.

INTERNATIONAL DESIGNATION

1990: Designated part of a Biosphere Reserve under the UNESCO Man & Biosphere Programme

1996: Mammoth Cave Area Biosphere Reserve area extended from 83,377 ha (367,979 ha).

IUCN MANAGEMENT CATEGORY

II (National Park)

BIOGEOGRAPHICAL PROVINCE

Eastern Forest (1.05.05)

GEOGRAPHICAL LOCATION

Located in south-central Kentucky, 135 km south of Louisville, and 4 km northwest of Park City which lies within the Transition Zone of the Park between 37° 07' to 37° 17'N and 86° 00'-to 6°17'W.

DATES AND HISTORY OF ESTABLISHMENT

1926: The National Park was authorised under enabling legislation of the US Congress 56 Statute 317;

1941: Park fully established by 44 Statute 635. Kentucky ceded jurisdiction over Park lands to the National Park Service by an act approved in 1930: accepted 1944;

1965: Exclusive jurisdiction over the remainder of the land accepted. Certain roads through the Park are legally open to the public under Deed 262 of 1945;

1988: Part of the area was endorsed by a resolution of the Barren River Area Development District. The State of Kentucky designated Big Woods old-growth forest a state natural area, Green River a wild and scenic river, and Green River and Mammoth Cave subsurface streams outstanding resource waters;

1990: Recognised as a UNESCO Biosphere Reserve; greatly extended in 1996 to cover the cave's recharge area.

LAND TENURE

The National Park core area is federally owned and is managed by the National Park Service (NPS). Southeast of it, a transition zone of equal size which covers much of the cave's water recharge area is managed by a range of owners.

AREA

National Park: 21,191 ha.

ALTITUDE

Ranges from -115m to a surface level between 180m and 231m.

PHYSICAL FEATURES

The Park, which extends under two ranges of hills, is situated on the Mammoth Cave Plateau and contains a karst area of international importance. The core area is a dissected plateau called the Chester Upland, comprising two sandstone-capped ridges which protect the underlying caverns, separated by limestone valleys pitted with sinkholes. It contains the longest cave system in the world, in a many-levelled labyrinth, with known passages extending for over 550 km and to a depth of 115m. Most types of limestone cave formation are found here, including long passages with huge chambers (Mammoth Dome is 58m high), vertical shafts, stalagmites, stalactites and gypsum flowers and needles. On the surface there is a superb karst topography with largely subsurface drainage, sinkholes, cracks, fissures and springs. Groundwater flows from the extensive recharge areas on the plateau, southwest through the park's cave system to springs that discharge into the Green River. Erosion by the Green River and its tributaries, which formed this system, began over 25 million years ago and the old river meanders are now deeply incised.

The limestone rocks of Upper Mississippian age are highly soluble and contain fossils throughout, including brachiopods, crinoids and corals. The main series, in which the cave systems and karst landscape have developed, are the St Louis, St Genevieve and Paoli limestones of the Meramecian. The Chester Upland is capped by sandstones of the Upper Mississippian-Lower Pennsylvania periods. Structural dip in the north-west is about 5m/km. The major soil types are those developed from limestone residuum and are either alfisols or ultisols. To the east, south and west of the Park (included in the Transition Zone) is the Pennyroyal Plateau, separated from the upland by an escarpment. This is not capped by sandstone and has eroded to a lower level, with many sinkholes.

CLIMATE

Climatic conditions are humid temperate. The mean annual precipitation is 1,118mm at 205m, practically all in the form of rain as temperatures are generally above freezing during the day. The National Parks Conservation Association claims that this rainfall is ten times as acidic as the national average (NCPA, 2003). The mean annual temperature is 13.6°C with a summer mean of 26.6°C and a winter mean of 1.7°C (MAB USA, 1990).

VEGETATION

The surface vegetation includes 84 tree, 28 shrub and vine, 29 fern, 209 flower, 67 algae, 27 fungi and seven moss species. An inventory of the flora is included in the Biosphere Reserve nomination. Big Woods is reputed to be one of the largest and best remaining examples of the ancient forest of eastern North America that once covered Kentucky. This temperate deciduous oak-hickory forest is dominated by oaks including white, black and chestnut oaks, *Quercus alba*, *Q. velutina*, *Q. prinus* and hickories including pignut and mockernut, *Carya glabra* and *C. tomentosa* with some beech *Fagus* sp., maples *Acer* spp., tulip tree *Liriodendron tulipifera*, ash *Fraxinus* sp. and eastern red cedar *Juniperus virginiana* (MAB USA, 1990).

FAUNA

This is the most extensive and diverse cave ecosystem in the world, with a unique fauna of over 200 species, mostly invertebrate, indigenous to the network of caves, with 42 species adapted to life in total darkness. The terrestrial vertebrates include 43 mammal, 207 bird, 37 reptile and 27 amphibian species (Uhler, 2002). The age of the geological formations has contributed to the species richness of the cave fauna, the cave system being old enough to have communities from three karst regions and covering an area large enough for speciation to have occurred. The inflowing Green River has 151 fish and 71 of the state's mussel species. Mussels are valuable indicators of water quality, especially of sedimentation. Nowhere else do blind northern cave fish *Amblyopsis spelaea* (VU), *Typhlichthus subterraneus* and their spring cave-dwelling relative *Chologaster agassizi* co-exist. Resident endangered animal species include Indiana bat *Myotis sodalis* (EN), gray bat *M. grisescens* (EN), fanshell mussel *Cyprogenia stegaria* (CR), crackling pearly mussel *Hemisterna lata* (CR), ring pink mussel *Obovaria retusa* (CR), rough pigtoe mussel *Pleurobema plenum* (CR), and clubshell mussel *P. clava* (CR). 45 other mussel species also inhabit

the caves. In addition, the federally endangered bald eagle *Haliaeetus leucocephalus* has been seen wintering and may even be nesting in the Park, and the uncommon red-cockaded woodpecker *Picoides borealis* has also been seen there. Wild turkey *Meleagris gallopavo* and beaver *Castor canadensis* have been successfully reintroduced (NPS, pers.comm.,1995).

CULTURAL HERITAGE

Radiocarbon dating of cultural material indicates that prehistoric people entered Mammoth and other Park caves almost 4,000 years ago to explore and mine cave minerals. There are 1,008 identified prehistoric and historic archaeological sites in the Park, representing almost 10,000 years of human history including the first evidence of organised horticulture on the continent. Mammoth Cave was first recorded by Euro-Americans in the late 18th Century and saltpetre was mined for gunpowder by slaves between 1812 and 1819. The area became popular with tourists thereafter and was lightly settled during the 19th century. The museum collection contains more than 30,000 objects, including a Hercules steam engine and coach listed in the National Register of Historic Places. Additional listings include 28 structures and an archaeological site. Guided tours began in 1916, and until 1926 when legislation to establish Mammoth Cave National Park was passed, the cave was operated as a tourist attraction by a succession of private owners (NPS, pers. comm.,1995).

LOCAL HUMAN POPULATION

There are no permanent inhabitants in the core area. About 240 people live in the buffer zones with a further 1,500 in the transition area, including over 600 in Park City. Population density in the region surrounding the Park is low (30 per sq. km) and has remained stable for the past 20 years. Only 25% of the population is considered urban and no significant increase in urbanisation is expected in the near future. Most people are engaged in agriculture, tourism or service industries. The Cave's recharge area is covered by the extended Biosphere Reserve within which 67,000 people live (MAB USA, 2004).

VISITORS AND VISITOR FACILITIES

Since a peak in 1979 of 1.6 million visitors, numbers remained stable into the 1980s, but have recently increased to about 2 million per annum. The summer months of June, July and August see over 60% of the annual total. Park headquarters and a visitors' centre are located at the historic entrance to Mammoth Cave. Several guided tours of the caves are offered and there are commercial boat trips on Green River. There are 155km of roads within the park and many hiking trails, including over 73km in the remote areas. There are only two small ferries across the Green River so that resources in remoter areas remain untapped. Access is good and it is estimated that a third of all visitors do no more than drive through the Park, but it offers a challenging experience to cave divers. There is a hotel, lodge and various cottages, restaurant and shopping facilities in the buffer zone. A further 2,000 motel rooms and over 7,500 campsite places are located within easy distance of the Park (MAB USA, 1990).

SCIENTIFIC RESEARCH AND FACILITIES

Long-term hydrological and ecological research into karst systems is being carried out in the Mammoth Cave area, including the effects of water quality on the cave's biota. In particular, research into groundwater flow-pulse rates and modelling has been applied to the development of instrumentation packages for monitoring the physical and chemical properties of groundwater. Preliminary discussions on the international applications of this have been initiated and much research has already been carried out. A research facility and laboratory are available to visiting researchers (MAB USA,1990). Partnerships with numerous agencies, organisations and universities exist: with Ball State, Tennessee, Clemson, Eastern Kentucky, Western Kentucky, Murray State, Louisville, the Kentucky Nature Preserves Commission, Barren River Area Development District, and The Nature Conservancy, all of which offer opportunities for research, education and training (NPS, pers.comm.,1995).

CONSERVATION VALUE

The Mammoth Cave area is an internationally important area of karst, containing the longest cave system in the world, with known passages extending for over 550 km and containing most types of limestone cave formation. Over 200 species of animal are indigenous to the caves including several endangered species of blind fish, shrimp, bat and freshwater mussel. Big Woods, a temperate deciduous oak-hickory dominated forest, is one of the largest and best remaining examples of the ancient forest of eastern North America. Archaeological sites in the area show evidence of four pre-

Columbian Indian cultures. The Park lies within a WWF Global 200 Freshwater Eco-region and a UNESCO Biosphere Reserve.

CONSERVATION MANAGEMENT

The core of the Park is managed by the National Park Service. The Transition Zone falls within Barren River Development District, of which three counties are within the Mammoth Cave system recharge area. The Biosphere Reserve Cooperative Subcommittee of the Natural Resources Council of the Barren River Area Development District will coordinate Biosphere Reserve functions (MAB USA, 1990). Of particular concern to the Mammoth Cave area are the impacts of agricultural, commercial and residential land uses on ecosystems overlying the limestone watershed - especially concerning the effects of groundwater pollution on cave biota. The 1983 general management plan for the National Park states that management objectives are to perpetuate the integrity and diversity of the geological features and life systems associated with the caves and to preserve aquatic and terrestrial environments for their aesthetic, recreational, educational and scientific values. Within the core area the management plan identifies natural and historic zones and classifies caves into six types, according to approved access. A resource management plan has been compiled which includes natural and cultural resource management programmes (Anon., 1988).

The oak-hickory woods of the National Park are being allowed to return to their natural state. Some of the oak and poplar forests are currently managed but there are no plantations. As well as public recreation, authorised fishing is permitted in the core area. Narrow corridors along roads within the core zone have been designated as zones of managed use, and tourist developments, administrative and recreational facilities are concentrated within them. The Transition Zone established for the Biosphere Reserve has been designated to the south and east of the core area to curtail groundwater pollution, as this is where much of the rainwater falls which flows through the cave systems of the Park. Federal, state and local authorities have cooperated to develop a regional sewer system in the area surrounding Park City, to stop pollutants reaching the groundwater (Anon, 1988). Gates on several cave entrances are being designed to allow natural air flow and movement of cave organisms. Several the artificial entrances are being refitted with airlocks to prevent microclimatic changes, especially drying, which can harm speleothems and cave organisms (NPS, pers. comm., 1995).

MANAGEMENT CONSTRAINTS

Damage to irreplaceable cave features occurred during the early periods of cave use, including smoke deposits from torches, fires and graffiti. The use of electric lighting for cave tours has also led to the introduction and growth of mosses, fungi and algae in the caves and may eventually spoil the natural beauty of some of the unique formations. At least 130 cave entrances need some level of monitoring against illegal entry. Several cave gates are in need of repair. Oil and gas wells were also drilled in this area. Those inside the Park were abandoned when it was established, but still pose a threat to human safety and environmental quality, many having been insufficiently plugged. In adjacent areas, oil and gas exploration has increased recently and with this, the risks of spillages into the Park's groundwater system including that of dyed injected to ascertain water flow (Ek *e tal.*, 1999). About half of the Mammoth Cave system actually lies outside the National Park boundaries but management of these areas should be improved by the designation of the Transition Zone and the Biosphere Reserve. Commercial freshwater mussel fishing outside the Park has destroyed the natural mussel beds there and illegal operations have expanded into the Park, resulting in conviction of the operators (MAB USA, 990). Poaching for wild ginseng is also an issue.

A wide variety of arable and livestock farming occurs in the Transition Zone and light industry is now increasing in the area. However, solution of the existing pollution problems should attract sustainable economic development compatible with the karst terrain. Of major environmental concern is the extensive sinkhole plain in the Transition Zone to the south and east of the Park. Run-off from this area flows via underground streams into the Green River and includes effluent from Park City. There has also been illegal dumping of wastes into sinkholes in this zone. Any changes in the quality or quantity of water would adversely affect the unique aquatic life in the underground streams and alter natural cave development. The local problem is now being addressed, but in 2002 the WHC was very concerned about the development of a proposed 1500 ha Kentucky Trimodal Transpark/airport 12 km away on the edge of the Park's water catchment. This was proposed without a thorough prior environmental impact assessment of the probability of chemical pollution of the whole system of underground water by oil and industrial run-off (Brucker, 2002). The WHC urged that detailed hydrogeologic studies should be made before construction

(UNESCO, 2002). Another threat is haze from fine particle pollution and acid rain which already make this park one of the most polluted in the country, which could be aggravated by development of the Transpark and of a nearby coal-fired power plant (NCPA,2002).

STAFF

The Biosphere Reserve has 94 staff. Of these, 20 are involved in administration, control and resource management within the core area; 17 are university educated. There are 12 staff for education and training and three involved in research with up to 10 technical support staff (MAB USA, 1990).

BUDGET

US\$ 3,500,000 annually (MAB USA,1990)

LOCAL ADDRESS

The Superintendent, Mammoth Cave National Park, Mammoth Cave, Kentucky 42259, U.S.A.

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The principal source for the above information was the original nomination for World Heritage status.

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