Conservation & Management Tuesday

Session chair: Val Hildreth-Werker, Moderator NSS Conservation Division Joint Chief
Tuesday: 9am-4:00pm
Bridger Steel Building

Tuesday Talks include cave and karst conservation and management, minimum-impact-science-based decisions, stewardship, education/outreach, karst aquifer watershed protection, spelean habitat ecosystem findings, bat study updates, clean-caving ethics, WNS decon systems, as well as advancements in cave restoration, speleothem repair, and low-impact caving methods. Join us for lively speleological presentations and discussions exploring state-of-the art conservation solutions and current best practices.

A Special Workshop on methods for the repair of speleothems starts at 2:00 PM. (See below). This Cave Formation Repair Workshop by Mike Mansur offers a hands-on intro-duction to repair techniques in the classroom. An opportunity for in-cave practice will fol-low on the next day.

Section/Session Schedule

Time	Speaker	Topic
9:00-9:20	Pat Seiser	Update on status of the NPS Cave and Karst Program and NCKRI's programs.
9:20-9:40	Georgia Schneider	CKRIT: The Cave and Karst Resources Information Tracking Database
9:40-10:00	Andy Armstrong	Cave Pool Water Chemistry Analysis Reveals Beneficial Impact to Speleothem Growth Resulting from Microclimate/CO_2-Focused Management of Cave Tours
10:00-10:20	Erin Lynch	Removal of Potentially Hazardous Material from Cave C-18, Carlsbad Caverns National Park: Logistics and Lessons Learned from a Multi-Agency Operation
10:20-10:30	BREAK	
10:30-10:50	Ceth Parker	The Urgen Need for Extraterrestrial Subterranean Conservation
10:50-11:10	Ethan W. Oleson	The Conservation in Rushmore Cave, Black Hills – Show Cave Conservation Lesson
11:10-11:30	Kate Forel	Characterizing Air Quality and Health Concerns in Tumbling Rock Cave: An Exploratory Study
11:30-11:50	Charles and Catherine Bishop	James Cave and Coach Cave Restoration
11:50-12:10	Ray Keeler	NSS-USFS Cooperation Initiatives: Stepping Up to Better Understand, Access, and Manage Caves in the National Forests
12:10-12:30	Arun Bista	Nepal: Patal Bhuvaneshwar Cave
12:30-12:50	Lilliana Wolf	Bats as a viral vector: implications for conservation and pandemic preparedness
12:50-1:00	BREAK	
1:00-2:00	John Scheltens	Luminary talk on development and Congressional activity on passing the National Cave and Karst Protection Act of 1988.
2:00-4:00	Mike Mansur	Cave Formation Repair Workshop

Abstracts

(listed in alphabetical order by main presenter)

Cave Pool Water Chemistry Analysis Reveals Beneficial Impact to Speleothem Growth Resulting from Microclimate/CO2-Focused Management of Cave Tours

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Scientists from the U.S. National Park Service and Western Kentucky University recently completed a ten-year analysis of two cave pools at Timpanogos Cave National Monument in Utah. Hansen Lake is a relatively large, isolated body of water at the end of Hansen Cave, while Hidden Lake is smaller and adjacent to the tour route. Analysis of 2008-2018 geochemical data from the pools showed that the calcite saturation index (SI_{cal}) for Hidden Lake stood out with surprising results among the many parameters studied. SI_{cal} data from Hidden Lake showed that the water in the pool changed rather abruptly from undersaturated to saturated conditions in 2013 and has remained so since that date. Unknown at the time, a new cave management plan implemented in 2013 appears responsible for this change. To mitigate physical and temperature impacts from large tours, the cave management plan limited tours to 16 visitors and added a "cool down" period of 15 minutes between tours. An unforeseen result was a reduction of CO_2 in the cave atmosphere with fewer people in the cave breathing. This management change returned the pool to oversaturated conditions, resulting in precipitation of calcium carbonate speleothems. Due to COVID-19, Timpanogos Cave was closed to visitors in 2020, allowing summer baseline microclimate and CO_2 conditions to be recorded without visitors inside the cave for the first time in the monument's 100-year history. Preliminary data confirms our hypothesis that the additionally lowered CO_2 would further drive increased SI_{cal} and mineral precipitation rates.

James Cave and Coach Cave Restoration

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Restoration activities to remove some of the impacts of commercialization have been a ten-year project in James Cave and Coach Cave. Located in Edmonson County, Kentucky just south of Mammoth Cave National Park, both caves are critical hibernacula for gray and Indiana bats whose presence has been documented since the mid-1800s. The caves were commercialized in the early 1960s to attract tourists to the Park Mammoth Resort located near Park City. Gating of the caves and winter disturbance by commercial tour groups had a significant negative impact on the hibernating bats. Winter tours in the caves were ended in the early 1980s, and all tours were discontinued by the late 1980s. Numerous bridges and stairways made from treated lumber had been constructed on tourist trails, and by the mid- 2000s these structures had deteriorated, creating a hazard for the cavers and biologists monitoring the bats. It was also suspected that the crumbling wood was releasing toxic chemicals into the cave air and water. Members of the James Cave Project set a long-term goal to remove all man-made structures and materials from the caves, and in 2015 the NSS Mammoth Cave Restoration Group became involved with the restoration effort. This group brought significant manpower to the effort, helping with deconstruction activities and moving tons of wet wood through the cave. Other groups involved in the ongoing project have been property owners, biologists from U.S. Fish and

Wildlife Service and Kentucky Department of Fish & Wildlife, and members of The Nature Conservancy's Kentucky chapter. This presentation will provide some history of the caves and their bat populations along with a progress report on the restoration project.

Nepal: Patal Bhuvaneshwar Cave

Arun Bista, Chairman, Patal Bhuvaneshwar Cave
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Patal Bhuvaneshwar Cave is the deepest cave in Nepal and might also be the deepest in Asia. Morris Deusen (French), president and cave expert of the International Center for the Exploration of the Himalayas conducted a preliminary survey of the cave and reached a depth of 800 meters. The cave is located within a 700-acre tract of forested land and on February 23, 2020, a local team was elected to work on developing and promoting the area. An additional 26 caves were also discovered within a two-mile radius of the cave.The Government of Nepal has funded more than $200,000 for infrastructure development to make it a major tourist destination. The Nepal Tourism Board also allocated funds for the research purposes but the work could not be done because of COVID. This presentation will highlight Patal Bhuvaneshwar Cave. As chairman of the management team I am planning to promote this area as a Village of Caves and invite cavers worldwide to conduct research there.

Characterizing Air Quality and Health Concerns in Tumbling Rock Cave: An Exploratory Study

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An estimated two million people visit caves each year, but little is known about their potential exposure to environmental hazards. This is an exploratory study to examine the use of citizen science tools to characterize air quality within caves. We aim to quantify exposures that cavers experience in subterranean environments and extrapolate these exposures into a human health risk assessment. A PurpleAir air quality monitor was placed inside Tumbling Rock Cave (located in Jackson County, Alabama, USA) for approximately 24 hours. The instrument collected real-time measurements of temperature, humidity, dewpoint, pressure, and particulate matter (PM). During this period, there was an average temperature of 49.42°F, average humidity of 50.26%, average dewpoint of 31.31°F, average pressure of 1006.2 millibars, average $PM_{2..5}$ concentration of 4.33 $\mu g/m^3$, and average PM_{10} concentration of 4.80 $\mu g/m^3$ Interestingly, there was an unexplained spike in PM at midnight, reaching measurements of 36.69 $\mu g/m^3$ $PM_{2..5}$ and 41.23 $\mu g/m^3$ PM_{10} . The 24 hour exposure limits for $PM_{2..5}$ and PM_{10} are 35 $\mu g/m^3$ and 150 $\mu g/m^3$, respectively. If these limits are exceeded, they could contribute to respiratory and cardiovascular health issues. Future studies will place the PurpleAir monitor in different locations within the cave, as well as use other instruments to measure additional air quality parameters, including CO_2, CO, and radon. This type of citizen science technology has the potential to transform cave management and allow cavers to be more aware of potential health risks they may face while caving.

NSS-USFS Cooperation Initiatives: Stepping Up to Better Understand, Access, and Manage Caves in the National Forests

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Over the last several years, and in several areas of the United States, the access to caves on our national forests has become limited. This has led to some strained caver/land manager relations. The spread of WNS and resulting management orders have contributed to the problem. Meanwhile in other parts of the country, NSS-USFS relationships have remained in excellent condition.

To address the problems, over the last 18 months, several focused long-term NSS and USFS efforts have been initiated to improve, repair, and address multiple issues on multiple levels. These include setting up agreements between the Washington Office, Regional Offices, and individual Forests with the national NSS, as well as NSS regions and individual grottos. **Most important of these is the new, five-year USFS-NSS MOU (signed June 2021) which allows the USFS to transfer FOIA exempt information to NSS lOs and individuals when local agreements are in place.** This talk goes over the accomplishments, tools that are now available, agreements, and mechanics that will help with better understanding, access, and management of the caves. This talk will also touch on several issues that remain and possible ways to address them.

Removal of Potentially Hazardous Material from Cave C-18, Carlsbad Caverns National Park: Logistics and Lessons Learned from a Multi-Agency Operation

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The FBI, working with the New Mexico State police and Bureau of Alcohol, Firearms, and Explosives, assisted the National Park Service to assess the contents of several containers labeled "blasting caps" in a sensitive area of Carlsbad Caverns National Park. Cave C-18 was known to have historical mining operations and the containers are estimated to be 100 years old. A unified command was established for the incident, NCRC-trained responders were pre-notified, and preliminary response plans were developed for a range of scenarios. The cave's vertical entrance pit complicated access for personnel and transport of specialized equipment. A high-line and hauling system were pre-rigged for the dual purpose of removing potential explosives and rescue preparation. Differing agency standards for vertical access techniques were addressed through training exchange prior to descent of the pit. X-rays of the boxes revealed that they were empty, and the boxes were removed without incident. The operation concluded successfully.

Cave Formation Repair Workshop

Instructed by Mike Mansur, NSS26393CL FE
Round Building

There are untold numbers of broken cave formations in the world's caves. The majority of these were caused by human impact, with a small amount resulting from natural causes. We, as cavers and scientists, want to do as much as possible to repair, restore and conserve these damaged resources. The Cave Formation Repair and Restoration Workshop will help train and educate people on techniques and tools that we use to make formation repairs.

The Conservation in Rushmore Cave, Black Hills – Show Cave Conservation Lessons

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Rushmore Cave, located near Keystone, South Dakota, is a privately-owned show cave with annual attendance that rivals that of the nearby National Park Service caves that have been running cave tours for 93 years. In 2019, Rushmore Cave started a Cave Conservation program that was one of the first in the nation in its scope and goals for private show caves. This program facilitated a full-time position with the goals of monitoring, maintenance, cave science, resources, collaboration, and education. Throughout this program's life, it has created new management procedures, new methodology, and new collaborations that continue to be developed. This case study focuses on lessons learned from applying and adapting state-of-the-art conservation and restoration techniques to a show cave budget and resources, as well as future goals and recommendations.

The Urgent Need for Extraterrestrial Subterranean Conservation

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The entrances to more than 2,500 extraterrestrial subterranean features (ESF) have been discovered via satellite identification of Subsurface Access Points (SAPs) across our solar system.They are assumed to be entrances to lava tubes, caves, subsidence 'sink-hole' like features, fissures, and yet to be described subsurface formations.These SAPs have thus far been identified on the Moon (221), Mars (1,036), Titan (1,297), Enceladus (100), Triton (3), Pluto (2), and Charon (1). On planetary bodies with minimal geologic activity and/or minimal ice-shell turnover, some ESF could be 1-4 billion years old. These features may contain evidence of climatic evolution and serve as records of environmental change over immense time periods. Additionally, it has been proposed that some ESF could contain remanent biosignatures of extinct life or even serve as habitats harboring extant life today. Semi-autonomous robotic architectures are being designed and built to explore these subsurface features, with the first lunar SAPs to be explored robotically within this decade, Martian SAPs to be explored within the next, and Ocean-Worlds soon to follow. Unfortunately, there is minimal communication between cave scientists and the robotic engineers designing and building these near-future subterranean explorers. The risk of irreparable damage to billion-year-old subsurface features is high without improved communication between the disciplines. Here we aim to start the crucial dialogue between cave explorers, cave scientists, and roboticists about approaches, high sensitivity features, robotic architectures, and management plans for ethical subsurface exploration. As with all conservation efforts, extraterrestrial subterranean conservation must be a delicate balance between scientific discovery and the preservation of natural features. Indeed, ESF cloud contain some of the most ancient and fragile geologic features in our solar system, and potentially shelter evidence of non-terrestrial life. These features require ethical considerations and protection plans developed well in advance of their exploration.

John Scheltens Luminary Talk

John Sheltons Luminary Talk will include development and Congressional activity on passing the National Cave and Karst Protection Act of 1988.

CKRIT: The Cave and Karst Resources Information Tracking Database

Georgia Schneider, CKRIT Intern, NPS
Secret Agent Intern for the NPS

The NPS is moving into the 21st century and creating a geocentric database for NPS units with caves and karst resources. The Cave and Karst Resources Information Tracking database (CKRIT pronounced secret) development is in its infancy. The goal of the national database will be to provide a secure database for geocentric management of cave resources to individual parks. The challenge will be to develop a comprehensive but flexible database that is secure for each cave resource office while providing upper level management information for reporting purposes (numbers and types, but not locations).

NPS: National Cave and Karst Program Coordinator
NCKRI: Director of Cave and Karst Management Science

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Update on status of the NPS Cave and Karst Program and NCKRI's programs.

Bats as a viral vector: implications for conservation and pandemic preparedness

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Mention to someone that you are a caver in 2022, and you will be asked a suite of curious questions. Many you have heard before and are entirely prepared to answer. The most recent and common one, however, you might need some freshening up on. "Why do bats carry so many viruses? Isn't it dangerous to be around them?" The response to this question should be more of a discussion than an answer. Bats play a complex role in the public health and ecosystem health of our global environment. They are uniquely adapted for flight in a way that does allow them to host and transmit many viruses. Their ecology and proximity to human activities also increase their ability to act as a zoonotic threat. But again, nothing in ecology or zoonotic epidemiology is quite so simple as "good guys" and "bad guys." Biology, human development, and politics all roll together in answering this question: in the wake of the Covid-19 pandemic, how should we consider the human-bat interface?