

COCONINO NATIONAL FOREST

RECOMMENDATIONS FOR CAVE AND KARST MANAGEMENT

01/07/2024

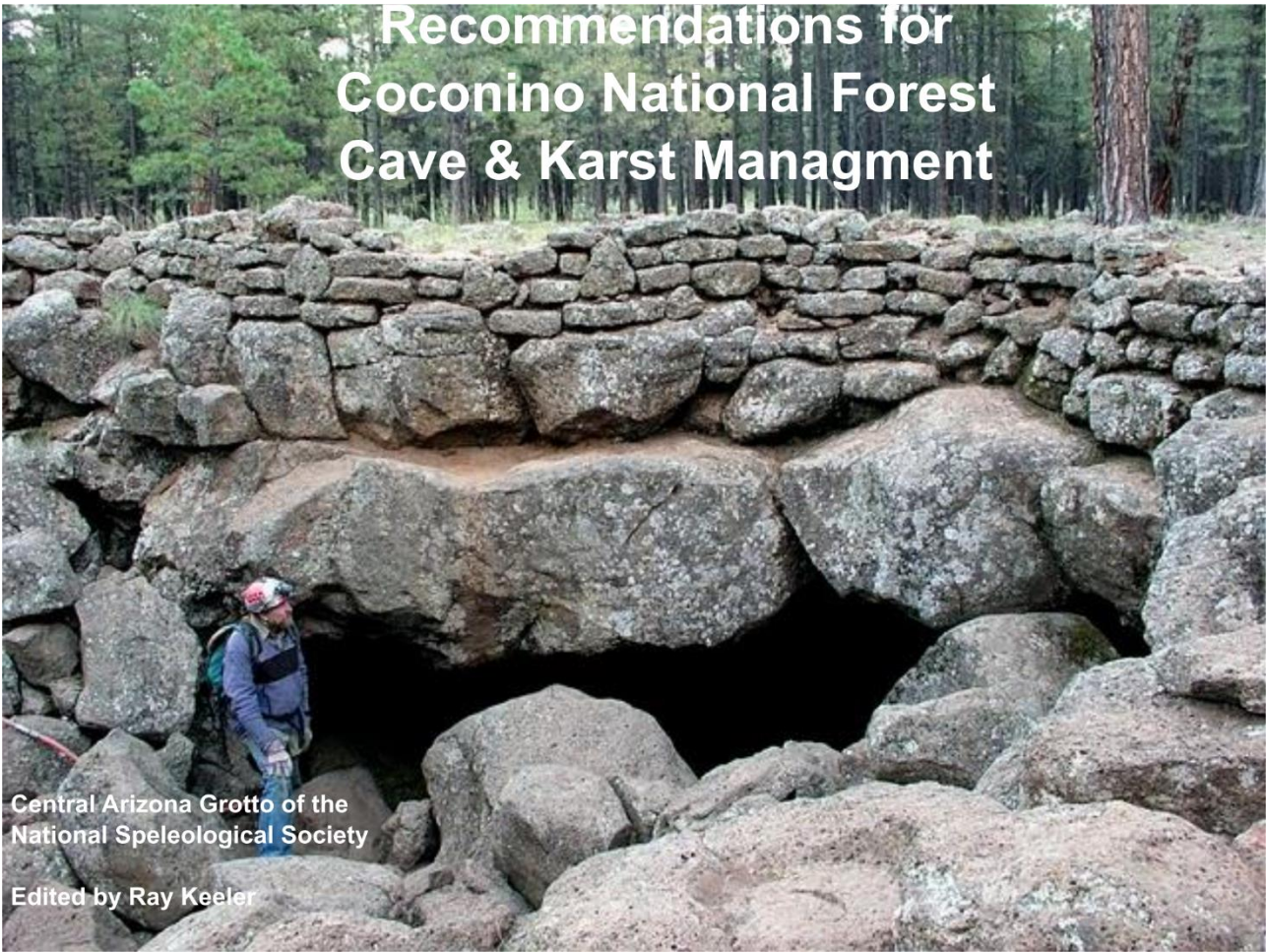


Table of Contents

RECOMMENDATIONS FOR CAVE AND KARST MANAGEMENT.....	1
1. INTRODUCTION.....	7
1.1. EXTENT OF CAVE & KARST RESOURCES – Coconino National Forest.....	8
2. AUTHORITIES.....	9
2.1 FEDERAL LAWS AND REGULATIONS	9
2.2 FOREST SERVICE MANUAL AND HANDBOOK DIRECTION	10
2.2.1 FOREST SERVICE MANUAL.....	10
2.2.2 CAVE MANAGEMENT OBJECTIVES AND POLICY	12
3 PROGRAM ADMINISTRATION AND MANAGEMENT	13
3.1 CAVE MANAGEMENT GOALS AND POLICY	13
3.2 KARST MANAGEMENT GOALS AND POLICY	14
POLICY	14
3.2.1 Strategy and Management.....	14
3.2.2 Surface Land Management - Karst.....	14
3.3 PUBLIC INVOLVEMENT.....	15
4 CAVE CLASSIFICATIONS AND EVALUATIONS	16
4.1 CAVE CLASSES.....	16
4.2 CAVE RATING GUIDELINES.....	18
4.3. FOREST/REGION CAVE NUMBERING SYSTEM.....	18
4.3.1 Cave Numbering System Examples	18
4.4 CAVE INVENTORY PROCEDURES	19
4.5 SIGNIFICANT CAVE NOMINATIONS	20
5 CAVE MANAGEMENT TECHNIQUES.....	21

Recommendations for Cave and Karst Management

5.1 CAVE MANAGEMENT PURPOSE AND SCOPE	21
5.2 CAVING ETHICS	21
5.3 CAVE RESEARCH GUIDELINES.....	21
5.4 CAVE SEARCH AND RESCUE (SAR).....	23
5.5 CAVE EXPLORATION.....	23
5.6 MONITORING	24
5.7 LIMITS OF ACCEPTABLE CHANGE (LAC)	24
5.8 GATING CAVES	24
5.9 CLEANUP AND RESTORATION PROJECTS	25
5.10 INDIVIDUAL CAVE MANAGEMENT FILES.....	25
5.11 ADAPTIVE MANAGEMENT	25
5.12 KARST MANAGEMENT TECHNIQUES	25
APPENDICIES	26
APPENDIX A - CAVING ETHICS	26
Ethical Caving Guidelines	26
Safety Considerations	27
APPENDIX B - CAVE RESEARCH GUIDELINES.....	28
Example Scientific Research and Collecting Permit.....	30
General Conditions for Scientific Research and Collecting Permit.....	32
APPENDIX C – CAVE EVALUATION AND CLASSIFICATION GUIDELINES	34
Cave Evaluation Guidelines	36
.....	37
CAVE RATING SUMMARY.....	37
APPENDIX D – SIGNIFICANT CAVE DESIGNATION PROCESS.....	38
What is a Significant Cave?.....	38

Recommendations for Cave and Karst Management

Resource - Criteria of Significance	38
Biology (B):	38
Cultural (C):	38
Geological/Mineralogical/Paleontological (G,M,P):	39
Hydrological (H) (caves with water):	39
Recreational (R):	39
Educational or Scientific (E,S):	39
Specially Designated Areas:	39
USFS Significant Cave Nomination Worksheet	40
.....	40
Significant Cave Finding/Decision	43
APPENDIX E - GENERAL INVENTORY PROCEDURES	45
Appendix E - General Inventory Form	47
APPENDIX F – CAVE MANAGEMENT TOOLS AND TECHNIQUES	50
F.1 Managing and Monitoring Elements	50
Visitor Registers	50
Conservation Messages and Interpretive Signs	50
Brochures and Handouts.....	51
Cave Maps.....	51
Cave Gates	51
Cave Trails.....	51
Access Authorization and Group Size Limits.....	51
Guides or Trip Leaders	52
Seasonal and Sensitive Area Closures	52
Road Closures, Upgrading and New Construction	52
Restrict Dispersal of Information	52
Take No Action.....	52
Active Management, Restricted Access and Closed Caves (Class 3 & 4 Caves)	52
Photo Transects (photo monitoring)	52
Impact Mapping.....	52
Wildlife Monitoring.....	53
Cave Climate Monitoring.....	53
Hydrological Monitoring	53
Air Quality Monitoring.....	53
F.2 Active and Non-Active Management Considerations	53
Active Management Considerations	53
Active Management Includes:	53
Active Management Caves	54

Recommendations for Cave and Karst Management

Directed Access Caves – CLASS 1	54
Active Management Caves (CLASS 3)	55
Non-Active Management Considerations	55
Non-Active Management – Lesser Known Caves (majority of caves)	55
Non-Active Management Caves (CLASS 2)	56
Preserve Caves (CLASS 4) - (Sensitive and Pristine Caves).....	56
APPENDIX G - INDIVIDUAL CAVE MANAGEMENT FILES.....	57
MASTER FILE	57
PUBLIC FILE	58
APPENDIX H – CAVE ENTRY AUTHORIZATION EXAMPLE	60
APPENDIX J – KARST MANAGEMENT.....	62
Key Karst Management Objectives	63
Karst & Volcanic Ecosystem Inventory Levels.....	63
Reconnaissance-level.....	63
Planning-level.....	64
Karst & Volcanic Ecosystem Field Assessments	64
Management Objectives and Practices for Significant Karst Features.....	65
Karst Assessment Criteria.....	65
Significant Karst Feature Protections.....	66
Surface Management Above Significant Cave Entrances	66
Riparian Management for Sinking / Losing Streams & Sinking Watercourses	68
Management Objectives.....	68
Management Practices and Mitigation Activities	68
Karst Management Practices for Grazing.....	68
Cave/Karst Description for Grazing	68
Grazing Impacts on Caves and Karst.....	69
Grazing Mitigations.....	69
Karst Management Practices for Road Construction	69
Road Location in Karst Terrain	69
Road Construction, Landings and Quarries	70
Maintaining Roads.....	71
Road Deactivation and Rehabilitation.....	71

Recommendations for Cave and Karst Management

Karst Management Practices for Timber Harvesting	71
Karst Management Post-Harvest Operations.....	73
Karst Catchment / Recharge Area Management.....	73
 GLOSSARY - TERMS AND DEFINITIONS.....	 74
 BIBLIOGRAPHY	 77
Author Credits	77
Colorado Cave Survey Acknowledgements.....	77
References.....	77
U.S. Forest Service Documents.....	77
Bureau of Land Management Documents.....	78
Other Documents	79
Online Resources	79

1. INTRODUCTION

This document, **Recommendations for Cave and Karst Management**, provides forest level recommendations for cave and karst management policies and techniques. The purpose is to provide guidelines to help with the administration and management of cave and karst resources on National Forest lands at a Forest level and to align with the Federal Cave Resources Protection Act of 1988 (FCRPA).

Cave specific management plans may be developed in subsequent years based on need and management priorities. This document also provides guidance in creating such management plans.

The intended audiences are Forest personnel assigned to caves and karst management, volunteers, and researchers so they can better understand and participate using existing directives and procedures.

Purposes

To protect and preserve significant caves on Federal lands pursuant to the FRCPA, while providing opportunities for quality recreation, scientific research and education, continuing exploration and ensuring visitor safety.

To foster increased cooperation and exchange of information between governmental authorities and those who utilize caves located on Federal lands for scientific, recreational, and/or educational purposes.

To address cave and karst management concerns, describing the recognition and protection of significant features which might be threatened by disturbances such as planned grazing, timber harvesting, mining activities, prescribed burns and non-sealed road construction. This Recommendations document provides best management practices and buffer zone descriptions for the protection of such significant cave and karst features.

Goals

The goals of the Recommendations for Cave and Karst Management are threefold:

1. Provide recommendations to help Forest personnel in consistently managing both the renewable and non-renewable cave and karst resources. The recommendations are supported by the resource by implementing Forest Service Manual (FSM) directives and the work with volunteers and cavers where possible.
2. Provide a structure under which volunteers and researchers can work under the supervision of Forest personnel to better understand the resource and management protocols.
3. Provide the public with a better understanding of techniques used for safer and conservation minded recreational caving.

To achieve these goals, Recommendations for Cave and Karst Management provides tools and information to address the various management needs.

- List federal laws relevant to cave management. That is: What are the cave management requirements?

- List Forest Service Manual (FSM) and Handbook directives including FSM cave management policies.
- Public Participation included in the FSM
- Evaluation criteria used in generating cave Classes based on the FCRPA Significant Cave categories.
- Cave management and techniques with respect to the cave Classes
- The USFS Significant Cave Nomination form and evaluation areas
- Significant Cave Finding/Decision form and associated responsibilities
- Cave Monitoring areas, Ethics, Research Guidelines and Karst Management recommendations

Organization

This document is organized as follows:

- The **Chapters** describe the strategic management requirements based on the laws (authorities) and the FSM policies implementing the laws. FSM references are provided.
- The **Appendices** describe the tactical techniques for sustainable and conservative cave and karst management. Included are ethics guidelines, Significant Cave Nomination Form, file management, surface management, research guidelines, monitoring techniques, cave management classification, confidentiality, and more. **Hyperlinks** allow easier access between the policies and the implementation techniques.

Editor's note: In several places the word "will" is used. In these cases, the text is taken verbatim from the Forest Service Manual, Code of Federal Regulations, and policy and procedures. References for these are in-line and as footnotes.

1.1. EXTENT OF CAVE & KARST RESOURCES – Coconino National Forest

Coconino National Forest has very large areas of karst and active karst. The Forest has many caves, most of which are only well known by local cavers. Two general types of caves are found on the forest. Lava tube caves and caves found in karst and pseudo karst terrain such as in the Verde Formation sediments. The Forest contains many different types of caves and cave features: shelter caves, earth cracks (fissure caves), maze caves, stream caves, sinkholes, lava tubes and pits.

Coconino National Forest has large areas of karst and pseudo karst in basalt areas. Karst areas in the Mogollon Rim Ranger District are the recharge lands for springs in Tonto National Forest below the Mogollon Rim. The Tonto Creek Fish Hatchery in Tonto National Forest

The two primary types of caves are found on the Forest are lava tube caves and caves found in the Kaibab Limestone. Most of the lava tube caves are found on the Flagstaff Ranger District associated with basaltic lava flows. Caves developed in karst terrain are found on the Mogollon Rim, Flagstaff, and the Red Rock Districts and are developed in the Kaibab Limestone Formation. Sinkholes are found. There are also large areas of both karst and pseudo karst that have not yet been checked for caves. Additionally, there are caves in the surficial bedrock in the Sedona area which formed from the collapse of large water filled underground cave systems developed in the Redwall Limestone at depth (Lindberg 2010). There are also caves located in the Verde Valley associated with the Verde Valley Formation sediments.

The forest has documentation on caves that have been nominated as significant caves (Forest Service, 2011). One of the significant caves is the Lava River Cave which is a recreational cave that is open to the public. The significant caves variously meet the criteria for significance on the basis of their geologic/mineralogic/paleontologic values, biota, cultural values, hydrologic values, recreational, educational or scientific values. Several other caves are known in the files and some have a resource evaluation report written for them. Significant Cave nominations are currently being submitted and processed. To date, the Forest has information on more than 50 caves and karst features across the forest. **Appendix J – Karst Management** addresses the surface management guidelines in karst topography for timber harvesting, grazing and non-hard surface roads.

2. AUTHORITIES

2.1 FEDERAL LAWS AND REGULATIONS

The principal Federal laws and regulations affecting the management of caves on National Forest System Lands are:

1. The **Organic Administration Act** of June 4, 1897. (16 U.S.C. 551). This Act authorizes the Secretary of Agriculture to regulate occupancy and use of the National Forests. Regulations issued under the Act authorize protection of cave resources from theft and destruction (36 CFR 261.9a, 9b, 9g, 9h and 9i). Under 36 CFR 294.1, classification is authorized for special interest areas that are managed for recreation use substantially in their natural condition. Special closures are authorized under 36 CFR 261.53 to protect threatened cave resources.¹
2. **Federal Cave Resources Protection Act (FCRPA)** of 1988 (16 U.S.C. 4301-4309; 102 Stat. 4546). The purposes of this Act are to secure, protect, and preserve significant caves on Federal lands for the perpetual use, enjoyment, and benefit of all people; to foster increased cooperation and exchange of information between governmental authorities and those who utilize caves located on Federal land for scientific, education, or recreational purposes. The act sets forth management actions, confidentiality of significant cave locations, and describes permitting, prohibited acts, and penalties <https://www.govinfo.gov/content/pkg/STATUTE-102/pdf/STATUTE-102-Pg4546.pdf>
3. **Code of Federal Regulations (CFR) Title 36: Parks, Forest and Public Property, Part 290 Cave Resources Management.** June 17, 1994. These are the implementing regulations applying to cave management on National Forest System lands. They provide definitions pertaining to the processes for nomination, evaluation, and designation of significant caves set forth rules regarding the confidentiality of cave location information and the collection of cave information.
Part 290 Cave Resources Management: <https://www.govinfo.gov/content/pkg/CFR-2014-title36-vol2/pdf/CFR-2014-title36-vol2-part290.pdf>
4. Title 36 CFR, Part 291: **Paleontological Resources Preservation Act** of 2009. These regulations set forth the requirements for managing, protecting, and preserving paleontological resources in the National Forest System (NFS) land using scientific principles and expertise.

¹ FSM 2356 authority

5. **Antiquities Act** of 1906 (34 Stat. 225; 16 U.S.C. 431 et seq.). This Act provides for the protection of historic and prehistoric remains or any object of antiquity on Federal land. Criminal sanctions are authorized for the destruction or appropriation of antiquities. Scientific investigations of antiquities on Federal lands are permissible subject to permit and regulations. Uniform rules and regulations pursuant to this Act are in FSM 1530.12. ²
6. The **National Environmental Policy Act (NEPA)** of 1969 is itself only a couple of pages long and simply compels all Federal Agencies to do the following prior to undertaking an activity:
 - A. Consider environmental impacts (environmental analysis) in decision making,
 - B. Involve the public
 - C. Document the process by which the agency made its informed decision.Federal Agencies are required to evaluate the relevant environmental effects of federal actions. This is accomplished by one of three levels of analysis depending on the complexity and type of action being analyzed: a Categorical Exclusion (CE), an Environmental Assessment (EA)/Finding of No Significant Impact (FONSI), and, Environmental Impact Statement (EIS). ³
7. **Archaeological Resources Protection Act (ARPA)** October 31, 1979 (16 U.S.C. 470aa). This Act clarifies and defines "archaeological resources" and it prohibits the removal, sale, receipt, and interstate transport of archaeological resources obtained illegally from public lands. The Act authorizes the confidentiality of site location information, authorizes permit procedures to enable the study and investigation of archeological resources on public lands by qualified individuals, provides for substantial criminal and civil penalties, forfeiture of equipment used in the crime, and rewards for citizens who report the crime. The Act supplements but does not replace the Antiquities Act of 1906. ⁴
8. **Endangered Species Act** of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531). The Act was established to prevent the extinction of plant and animal life and to recover and maintain their populations by removing or lessening threats to their existence. The Act describes the process for determining endangered and threatened species, establishes prohibited acts, prescribes penalties, mandates a recovery plan, and defines cooperative relationships between agencies and states ⁵
9. **Freedom of Information Act (FOIA)** of 1967 (5 U.S.C. 552(b)(3)) allows the public to seek disclosure of Federal agency information, but also requires agencies to protect some classes of material from disclosure including documents that are not formal products of the agency or official correspondence.

2.2 FOREST SERVICE MANUAL AND HANDBOOK DIRECTION

2.2.1 FOREST SERVICE MANUAL

The Forest Service Manual (FSM) contains program level guidance for cave and cave ecosystem management, and assigns roles for leadership and coordination. The sections relevant to cave and karst resources are chapters 2356 and 2880. Chapter 2356 outlines the cave management responsibilities of

² FSM 2356 authority

³ http://ftbf.fnal.gov/wp-content/uploads/2015/06/NEPA_Process_Summary.pdf

⁴ FSM 2356 authority

⁵ FSM 2356 authority

Recreation, Heritage, and Wilderness Resources. Chapter 2880 describes the cave and cave ecosystem management responsibilities of Geologic Resources, Hazards, and Services.⁶

Below are excerpts relating to caves:

The responsibilities of the **Washington Office Director**, Minerals and Geology Management as it pertains to caves are:

FSM 2880.41 #10. Coordinate lead responsibility for cave and cave ecosystem management on National Forest System lands with the Washington Office Director, Recreation, Heritage, and Wilderness Resources. Forest Service Manual 2356 provides the direction for significant caves and karst features developed for recreational use; FSM 2880 provides direction for protection and management of non-recreational significant caves and their associated ecosystems.

The responsibilities of the **Regional Foresters**:

FSM 2880.42 #10. Develop criteria to define cave ecosystems in terms of geologic and hydrogeologic setting, development processes, airflow, and vegetal-, faunal-, and aquatic-associated resources in their Region.

The responsibilities of the **Forest Supervisors**:

FSM 2880.43 #8. Ensure that all caves within their jurisdictions are evaluated in accordance with the Federal Cave Resources Protection Act of 1988 and Title 36, Code of Federal Regulations, part 290 (36 CFR 290) and make a determination of significance for caves nominated for such designation.

FSM 2800 Minerals and Geology Manual

Chapter 2880 Geologic Resources, Hazards and

Services –discusses management of cave and karst resources and their ecosystems.

FSM Chapter 2880: https://www.fs.fed.us/im/directives/fsm/2800/wo_2880_Amend-2015-1.doc

Cannot be accessed directly. **The document can be accessed by going to:**

“Forest Service Manual (FSM Directive Issuance, Series 2000 - National Forest Resource Management” at <https://www.fs.usda.gov/im/directives/dughtml/fsm2000.html> for a list of the included documents.

Go down to "2800 - Minerals and Geology", "Index of documents", and download “2880 - Geologic Resources, Hazards, and Services”.

FSH 2809.15 Minerals and Geology Handbook

Chapter 25 Cave Safety Standards. Establishes a course of action that can be followed to assure minimal risk to people entering caves on public lands.

FSM 2300 Recreation, Wilderness and related Resource Management

Chapter 2356 Cave Management. Policy and direction relating to cave management.

https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5403594.pdf

⁶ Kovarik, J., Geologic Management of cave and karst resources on National Forest System Lands, 2013
https://scholarcommons.usf.edu/cgi/viewcontent.cgi?article=1013&context=nckms_2013

FSH 2809.15 Minerals and Geology Handbook

Chapter 25 Cave Safety Standards. Establishes a course of action that can be followed to assure minimal risk to people entering caves on public lands.

https://www.fs.usda.gov/im/directives/fsh/2809.15/wo_2809%2015_20.doc

2.2.2 CAVE MANAGEMENT OBJECTIVES AND POLICY

FSM 2356.02 – Objectives

Provide cave related recreational, cultural, educational, and scientific study opportunities that serve public needs. Balance surface resource management and cave use with the protection of cave values.

FSM 2356.03 – Policy

1. Manage caves as a nonrenewable resource to maintain their geological, scenic, educational, cultural, biological, hydrological, paleontological, and recreational values.
2. Classify caves containing outstanding values as Geological or Historical Areas (FSM 2372).
3. Emphasize wild cave management with few or no facilities to aid or facilitate use.
4. Develop management prescriptions for caves of significant value.
5. Coordinate surface and cave resource management activities.
6. Protect threatened, endangered, proposed and sensitive, species in accordance with the Endangered Species Act (16 U.S.C. 1531) and FSM 2670.
7. Protect cultural sites and deposits in accordance with FSM 2361.03.
8. Develop and foster communications, cooperation, and volunteerism with interested publics, Federal agencies, States, and local governments.

Other cave management directives include:

1. Manage caves as a nonrenewable resource to maintain their geological, scenic, educational, cultural, biological, hydrological, paleontological, and recreational values. (FSM2356).
2. Protect and preserve significant caves by regulating or restricting use, as appropriate, and monitoring the condition of cave resources. (FSM2882.5).
3. Identify the geologic components of ecosystems (including geologic processes, materials, landforms, fossils, caves, and significant outcrops) and monitor and manage them in a manner appropriate to meet Forest Service responsibilities for National Forest System (NFS) lands and resources (FSM 2880.3).
4. Classify caves containing outstanding values as Geological or Historical Areas (FSM 2372, FSM 2356).
5. Emphasize wild cave management with few or no facilities to aid or facilitate use (FSM 2356).
6. Develop management prescriptions for caves of significant value. (FSM 2356).
7. Determine the actions necessary for protection, mitigation and recovery of cave resources and ecosystems (FSM2882.5).
8. Coordinate surface and cave resource management activities (FSM 2356).
9. Determine the effects of all proposed activities on the hydrologic function, biological significance, safety, recreational opportunities, and cultural and paleontological resources of cave resources and ecosystems. (FSM2882.5).

10. Protect threatened, endangered, proposed sensitive species in accordance with the Endangered Species Act (16 U.S.C. 1531) and FSM 2670 (FSM 2356).
11. Determine the need for protection of cave resources and ecosystems as critical wildlife or aquatic habitat (FSM2882.5).
12. Protect cultural sites and deposits in accordance with FSM 2361.03 (FSM 2356).
13. Develop and foster communications, cooperation, and volunteerism with interested publics, Federal agencies, States, and local governments (FSM 2356).
14. Promote volunteer management agreements and the exchange of information with the scientific and recreational caving communities (FSM2882.5).
15. Secure all cave-related documents to protect cave locations (FSM2882.5).

3 PROGRAM ADMINISTRATION AND MANAGEMENT

Cave resources are both fragile and non-renewable and special considerations are required to provide resource protection and recreational opportunities.

3.1 CAVE MANAGEMENT GOALS AND POLICY

All caves should be eventually inventoried and evaluated Forest-wide under provisions of FCRPA to determine resources, conditions, and significance. Newly discovered caves can be inventoried and evaluated as they become known. These caves will be managed as significant until it is determined that the cave does not meet any of the FCRPA categories for significance.

Management priorities will be assigned based on the resource inventory, rating, classification and evaluation of current conditions, and long-term management objectives.

Cave management documentation will be prepared for all significant caves⁷ and other caves deemed appropriate. Cave files should include such information as interim protection measures, monitoring requirements, limits of acceptable change (LAC), funding priorities and management prescriptions. Cave management files may be prepared concurrently with cave inventories, and evaluation. There will be a Forest wide Cave Management Plan as well as individual Cave Management Plans for all Federally protected and significant caves. If this work cannot be performed by a Forest Service employee, it may be performed and/or organized by cavers under the approval, supervision, and guidance of the Forest Service.

Closure orders will be maintained at both the Forest and District Offices. The need for further restrictions, (e.g.s, closure orders, seasonal exceptions, access authorizations, gates), will be determined by the Forest for each cave as the management prescription is developed.

Management conflicts can be resolved based on the relative importance assigned to conflicting resource values. Compromises need to preserve the cave resources while maintaining recreation opportunities. An example of such a compromise would be seasonal closure of an important bat roost, while maintaining the opportunity to explore the cave the rest of the year.

⁷ Title 36 CFR 290.3 <https://www.govinfo.gov/content/pkg/CFR-2002-title36-vol2/html/CFR-2002-title36-vol2-part290.htm>

3.2 KARST MANAGEMENT GOALS AND POLICY

Coconino National Forest's has very large areas of karst and active karst. Some of the sinks are more than half a mile long. These karst areas are also the recharge lands for springs on Tonto National Forest below the Mogollon Rim including the Canyon Creek Fish Hatchery and the Tonto Creek Fish Hatchery. The karst management goal is to determine and manage significant karst features with respect to three dimensional characteristics, level of connectivity between the surface and subsurface, hydrological characteristics, geological, biological, scientific, archeological, historical, cultural and educational values, recreational and commercial values, variety and abundance, and visual quality.⁸

To address these goals karst management needs to recognize significant karst features and set buffers where possible that mitigate disturbances to the features. Buffer zones and siltation reduction activities can be implemented around karst features when planning for grazing, timber harvesting, mining activities prescribed burns, and non-sealed road construction. If the water from rain and snow remains on the surface due to ground disturbance clogging entry points, it will evaporate.

POLICY

Implement karst management for significant karst features that buffer and mitigate disturbances to the features. Buffer zones and siltation reduction activities around karst features and will be addressed when planning grazing, timber harvesting, prescribed burns, and non-sealed road construction in karst areas.

Unnecessary surface disturbance in karst areas causes siltation and blockage of aquifer recharge entry points. These include sinks, sinkholes, sinking streams and cave entrances. Arizona is experiencing a long-term drought. If the rain and snow water remain on the surface it will evaporate and not enter the aquifer.

3.2.1 Strategy and Management

Determine significant karst features and understand their importance.

1. Identify the management objectives and recommended management practices for significant karst features.
2. Implement buffer zones around significant caves and karst features.
3. Apply best management practices for thinning, fire reduction, and forest health.

3.2.2 Surface Land Management - Karst

Surface land management decisions need to include consideration of potential impacts to all caves and karst. Maintenance of cave microclimate, hydrology, and entrance vegetation is needed in order to protect long-term cave ecology and the microclimate. Most cave entrances are karst features. Surface land management guidelines for caves are in [Appendix J – Karst Management](#)

- Implement the different levels of karst inventories to determine their relation to karst management (Order 4 to Order 1).
- Identify the desired conditions and recommended management practices for sinking and losing streams/sinking watercourses.
- Reduce soil erosion around and into karst features.

⁸ <https://www.for.gov.bc.ca/hfp/publications/00189/Karst-Mgmt-Handbook-web.pdf>

Recommendations for Cave and Karst Management

- Reduce sedimentation into karst features.
- Understand how to apply the recommended management practices based on the assessed vulnerability of the karst.
- Apply best management practices to road building.
- Apply best management practices to timber harvesting.
- Apply best management practices to post-harvest operations.
- Apply best management practices for thinning, fire reduction, and forest health.
- Consider wildfire and prescribed fire impacts on karst features and caves.
- Understand the management objectives and recommend management practices for the non-karst portion of karst catchments.
- Understand the safety issues associated with karst terrain.

All management activities planned near or within a known cave and/or karst area need to be examined for potential impacts to caves and karst features. Activities which increase sedimentation, sterilize soil, change a cave's natural hydrology or water quality, add nutrients, pesticides, herbicides, or fertilizers, or modify the cave, cave entrance, or passages will not be permitted without evaluation and approval through the National Environmental Policy Act (NEPA) process.

A buffer zone of approximately 300-foot radius (may vary depending on site variables) should be established around cave entrances, infeeder drainages, and surface areas immediately over cave passages. This buffer zone should be evaluated for impacts to cave and karst resources and ecology. The 300 feet is a guideline and not a hard number. Nearby topography certainly contributes and should be taken into consideration. The areas of consideration should include all necessary mitigation measures necessary to protect cave(s). Unauthorized major alterations to caves are not permitted. Cave entrances and karst features will not be used as livestock shelter or disposal sites for slash, waste rock, fill materials, storm water runoff, or other refuse.

3.3 PUBLIC INVOLVEMENT

FSM 2356.4 directs USFS personnel to

Encourage volunteer involvement for projects such as cave mapping, inventorying, planning, monitoring use, guiding, and interpretation through development of adopt-a-cave programs, volunteer agreements, and memoranda of understanding.

Public involvement and participation will be encouraged to develop and enhance the efficiency and quality of cave management. The Forest may seek input and participation from interested individuals and organizations, such as caving groups, scientists, and recreationists to encourage and develop their interests in managing the cave and karst resources. *However, management of the caves and their resources is solely the Forest Service's responsibility.*

The Forest, with each District's input should develop and maintain a current mailing list of interested parties regarding cave management. The mailing list should be utilized to announce resource activities planned within each District.

Specific information concerning significant caves on the Forest will not be made available to the public (36 CFR §290.4). This information will be treated as confidential and secured in such a manner as to prevent access by non-authorized individuals. The cave coordinator will maintain the cave files and ensure that access is provided on a need-to-know basis only.

Proposed policies and guidelines may be circulated to interested groups, grottos, and individuals for review. The Forest and Districts may include interested parties on an as needed basis to discuss current activities and plan for future projects. Confidentiality will be used in protecting cave location information as required by FCRPA.

The Forest may utilize volunteers and current cost-share agreements to complete projects when applicable. Responsibilities of volunteers will be established by the Forest and Districts prior to the approval of their work agreement.

4 CAVE CLASSIFICATIONS AND EVALUATIONS

FSM 2356.03 states that caves are to be classified so they can be managed to address the identified cave resource values. Note that Class definitions have been developed independently and vary between USFS Regions and Forests. Cave Classes may be changed, due to, for example, new discoveries being made or research information becoming available.

These five cave management Classes are grouped in part on the cave evaluations, and with respect to similar areas of cave management. As new caves are discovered they will be temporarily managed as **CLASS 5** until an analysis of resource values is completed.

These Cave Classes may be superseded by any specific or regional Forest Service Orders pertaining to changes in management or access, however they may revert back as any Order is rescinded.

Information concerning the location of caves will be kept confidential in accordance with provisions of FCRPA. Only the location of caves classified as "Directed Access" will be made available to the public.

4.1 CAVE CLASSES

The cave management classification system is used to establish priorities in cave management. Each cave is assigned a management priority based on its resource value, sensitivity level (exposure to destructive impacts), and Limits of Acceptable Change (LAC). Cave classification is the first step in cave management. Using the evaluation/ratings as a guide, the manager makes the decision about which of the classifications best fit individual caves. Prioritization focuses where active management and monitoring are needed, and where passive management and monitoring may be applied. There are no hard and fast rules for classification, and classifications are admittedly broad and somewhat generalized. What is most important is to determine if special management is needed or if changes in current management are warranted.

Classification of caves is not a substitute for cave management but rather a tool for sorting and categorizing individual caves in order to determine the best course for management. It is still necessary for the District Ranger to make prudent and specific decisions concerning the cave resources they manage.

Recommendations for Cave and Karst Management

CLASS	CAVE CLASS EXPLANATION
CLASS 1	<p>DIRECTED ACCESS CAVES: Caves with directed access for public use. These caves are on maps and may have signs directing visitor access. These caves may have guided tours and possibly artificial lighting. Regardless of any level of development, public visitation is encouraged. These caves do not have unique hazards to human use and may be suitable for use by the general public. Cave information may be provided and may include directions to the cave. Fulford Cave is one such example.</p>
CLASS 2	<p>NON-ACTIVE MANAGEMENT CAVES: Caves that are undeveloped but are suitable for recreational exploration by persons who are properly prepared. These caves include the vast majority of the caves on the White River National Forest. In general, these caves contain resources that resist degradation by moderate levels of recreational use. Public attention will not be directed toward these caves. Some features/biological resources may be present, but some level of impact will be accepted. Some of these caves will be monitored to determine if any negative effects are occurring over time.</p>
CLASS 3	<p>ACTIVE MANAGEMENT CAVES: Caves that have sensitive features and/or severe safety hazards, but may be entered without significant adverse impacts or undue danger by properly equipped and experienced cavers. These caves include caves with gates, caves having seasonal closures for biota (e.g. bats), or caves having special access restrictions for reasons such as cultural material sensitivity. There will be a range of management objectives in these caves. Individual cave management prescriptions are encouraged. The number of visits may be limited per month for caves with sensitive features. For groups wishing to enter caves with extreme safety hazards, the Forest may request that the group have adequate caving/climbing skills. The cave access authorization system may also serve as a monitoring tool.</p>
CLASS 4	<p>CLOSED AND RESTRICTED ACCESS CAVES: Caves that have extremely sensitive physical, biological, cultural or paleontological resources. Access to these caves will be via special access authorization and agreements. Individual cave management prescriptions are required. They may become part of a sample of caves that might serve as a baseline for undisturbed conditions.</p>
CLASS 5	<p>NEWLY DISCOVERED CAVES: Caves that have been recently discovered and yet to be thoroughly evaluated. Newly discovered caves, by definition, represent the entire spectrum of caves. The discovering team will be making initial judgements as they go in, making decisions as to the cave's well-being and minimizing impacts as they proceed. By default, the original discoverers are the initial cave managers and may help determine into which CLASS the cave may be placed. Newly discovered caves may be nominated for significant cave status under the procedures provided in the CFR Title 43 CFR § 37.11 - Nomination, evaluation, and designation of significant caves. Further information on this process is found in Appendix D of this document.</p>

4.2 CAVE RATING GUIDELINES

Several general questions contribute to the management Class selected for each cave or group of caves, including:

- Is the cave generally known?
- Is the cave gated or closed?
- What are the FCRPA areas of significance that apply?
- Are the cave and its attributes in danger?
- What areas does the Forest want to focus on for managing the cave?

The evaluation and rating process allows managers to evaluate the significance of individual caves and to objectively compare the relative values of different caves. This rating process allows identification of caves with high values or sensitivities to disturbance. Each cave's classification is also affected by the general public's awareness of the cave. There are generally known caves and lesser-known caves

This determination is beneficial for determining what information is publicly available. For example, a Directed Access cave may have information and directions available at the District or Supervisor's office.

All caves will be evaluated using a rating system that measures the resource Value and Sensitivity Level. The assigned rating will be used to determine cave classification and cave significance. The system allows Values of Low (L), Moderate (M) or High (H) to be assigned to various cave resources. The Sensitivity Level assigns values of low, moderate and high to the possibility of cave resources being impacted from visitation and human activities surrounding the cave such as timber harvests, mining and grazing permit changes. This rating process allows identification of caves with high values and/or sensitivities to disturbance. The evaluation process is described in more detail in each cave's evaluation. The evaluation can be the less formal [Appendix E - General Inventory Form](#), or the more formal [USFS Significant Cave Nomination Worksheet](#). These lead to classification and are contributory to determining a cave's significance. includes the evaluation process and addresses both areas with the [CAVE RATING SUMMARY](#).

4.3. FOREST/REGION CAVE NUMBERING SYSTEM

Cave inventories are helpful for making determinations of cave significance and classification but are not mandatory for nomination to the significant cave list. Cave inventories become increasingly important as management plans are developed for individual caves or groups of caves.

In addition to the cave's name, each cave will be assigned a unique cave inventory number that will be entered into the Forest Service INFRA system for management and tracking purposes. Cave numbers will be assigned to each cave entrance. Caves with multiple entrances will bear the same number at each entrance, followed by alpha characters (A, B, C, etc.) to differentiate between individual entrances. Cave numbers are assigned by Region, Forest, and Unit, followed by consecutive numbers for each cave on the Unit.

4.3.1 Cave Numbering System Examples

The following cave number designations and significance criteria are examples and need to be verified with Coconino NF files.

Table 1: Forest Service Cave Numbering System - These numbers should appear on all cave records	
03	Region 3
04	Coconino NF (Forest #4)
08	Flagstaff Ranger District (RD #8)
001	Cave No. 1 on the Unit
A	First Entrance Identified

Table 2: Forest Service Cave Numbering System.

Forest Service Cave Numbering System.	
03	Region 3 (Arizona, New Mexico)
##	Region 3 – Forest Numbers:
04	01 Apache-Sitgreaves NF 04 Coconino NF 07 Kaibab NF 10 Santa Fe NF 02 Carson NF 05 Coronado NF 08 Lincoln NF 12 Tonto NF 03 Cibola NF 06 Gila NF 09 Prescott NF
##	Forest – Ranger District Numbers:
08	06- Red Rock RD 07- Mogollon Rim RD 08- Flagstaff RD
###	Cave No. ### on the Unit
A	First Entrance Identified

The first cave on the Flagstaff Ranger District would have a designation of 3 04 08 001 A.

'x' designates Significance in this resource area.

Cave Name	Cave #	Region	State	Forest	District	(B)	(C)	(G,M,P)	(H)	(R)	(E,S)	(HAZ)
Lava River	30408 - 001A	03	AZ	Coconino	Flagstaff	x				x	x	
Pivot Rock Springs	30407 - 002A	03	AZ	Coconino	Mogollon Rim		x	x	x	x	x	

* Criteria include (B)iological, (C)ultural, (G,M,P) Geologic/Mineralogic/Paleontologic, (H)ydrologic, (R)ecreational, or (E,S) Educational or Scientific, Hazard (HAZ). [NOTE: Above cave number designations and significance criteria are examples and need to be verified with Coconino NF files.](#)

4.4 CAVE INVENTORY PROCEDURES

Locating and evaluating caves on the Forest is an ongoing process. As new caves are found and as additional information is collected, the inventory list will grow. The Forest **may** pursue collection of inventory data using in-house personnel, contract specialists, and subject matter experts from the caving communities through volunteer agreements, challenge cost-share agreements (CCSA), Memorandums of Understanding (MOU).

Assistance should come from local cave management partner organizations/agencies, volunteers and other stakeholders. Information collected during the cave inventory process is described in more detail in [Appendix E - General Inventory Procedures](#).

Each cave will be assigned a unique name and inventory number that will be entered into the Forest Service Natural Resource Manager (NRM) Cave Module system for management and tracking purposes.

Cave locations are recorded in Geographic Information System (GIS) and will be placed on a separate, secure layer. All inventory records will be maintained in a locked file **and will only be maintained by**

the Forest and District offices. Access to these records will be permitted on a work based/need-to-know basis. Generalized information which does not lead to the disclosure of cave locations, may be made available if it is determined that such disclosure would not constitute a threat of theft, damage, or harm to cave resources, and is consistent with the purposes of the FCRPA, the implementation regulations, Forest Plan Standards and Guidelines, and FSM 2356.

A permanent data file will be maintained in hardcopy and electronic format for each significant cave. The files will remain secure with access only provided on a work based/need-to-know basis. Additional information regarding Master and Public files are provided in [Appendix G - Individual Cave Management Files](#).

Cave inventory numbers will be assigned to each cave entrance. Caves with multiple entrances will bear the same number at each entrance, followed by letters (A, B, C, etc.) to differentiate between individual entrances. Cave inventory numbers contain specific information regarding the Region, Forest and Unit, followed by consecutive numbers for each cave in the specific area.

All persons involved in an inventory should be knowledgeable and aware of the spectrum and fragility of cave resources on the Forest so that these resources are not inadvertently damaged. Inventory participants will abide by "caving ethics" in [Appendix A - Caving Ethics](#) and should also be familiar with other known caves in the area.

4.5 SIGNIFICANT CAVE NOMINATIONS

The Forest Service implementation regulations for FCRPA establishes rules for the determination of cave significance (36 CFR §290.3). To be found significant, a cave must possess values in one or more of the following categories: Biological, Cultural, Geological/Mineralogical/Paleontological, Hydrological, Educational, or Scientific. In addition, all caves located within a special management area, designated wholly or in part due to cave resources found therein, shall also be determined significant.⁹ This includes such areas as national monuments, special areas, research natural areas, or other areas of special interest.

Caves that meet the criteria for significance will be formally nominated as a significant cave and processed for designation. Forest Supervisors are responsible for significance designation. The responsibilities of the Forest Supervisor are stated in FSM 2880.43 #8.

Caves determined to be significant will be governed under provisions of the FCRPA with an objective to secure, protect, and preserve significant caves for the perpetual use, enjoyment, and benefit of all people, and to foster increased cooperation and exchange of information with those who utilize caves for scientific, educational, or recreational purposes.

Caves not determined significant will be managed under the Standards and Guidelines of the Forest Plan, FSM 2356, FSM 2880 and 36-CFR; §261-Prohibitions.

Significant cave nomination worksheets and additional information can be found [Appendix D - Significant Cave Designation Process](#).

⁹ 36 CFR §290.3d Specially designated areas.

5 CAVE MANAGEMENT TECHNIQUES

Cave management occurs on multiple levels and in many areas. What follows is a brief overview of several of the top-level areas of cave management. A more detailed review can be found in the Appendices. The goal is to appropriately manage caves based on each cave's Class and attributes. Several techniques are included below. The line officer can choose which are appropriate for the need at hand.

5.1 CAVE MANAGEMENT PURPOSE AND SCOPE

1. To protect and maintain significant cave resources in accordance with the policies outlined in the Forest Service Directive System and management direction contained in the Forest Plan (CFR 36 Part 290 FS implementation).¹⁰
2. To provide cave related recreational, cultural, educational, and scientific study opportunities that serve public needs (FSM 2356).¹¹
3. To balance surface resource management and cave use with the protection of significant cave values (FSM 2356).
4. To interpret surface and subsurface geological conditions and processes (such as caves and karst) as they relate to or affect the capability of National Forest System lands to produce renewable and non-renewable resources (FSM 2880).

A variety of management techniques can be used to protect valuable cave resources. These may be used as individual techniques or in different combinations, A description of common management techniques is presented in [Appendix F – Cave Management Tools and Techniques](#).

5.2 CAVING ETHICS

Educating the public on the importance of preserving cave resources is an integral part of cave management. Guidelines outlined in [Appendix A - Caving Ethics](#) will assist Forest Service personnel in educating the public, and allow the public the opportunity to familiarize themselves with proper caving etiquette.

5.3 CAVE RESEARCH GUIDELINES

The USFS recognizes the value of having scientific research conducted within caves and in areas containing karst landforms on public forest lands. Information gained through research not only contributes to the general knowledge of caves, but ensures that responsible management of these non-renewable natural resources is informed, appropriate, balanced, and science-based. Scientific research conducted in caves is thus in the public interest both for the advancement of science and as a conservation management tool.

Guidelines to be incorporated into research permits are provided in [Appendix B - Cave Research Guidelines](#)

Caves are not isolated features; they consist of elements that are fully integrated into the landscape. Thus, management of lands overlying caves, occurring within a watershed in which caves are present,

¹⁰ CFR 36 Part 290.1 Purpose and scope, paraphrase

¹¹ The manual (FSM 2372 – US Forest Service) https://www.fs.usda.gov/im/directives/fsm/2300/wo_2370-Amend%202021-3.doc

or having hydrologic or other physical connectivity with caves is integral to the maintenance and conservation of caves and their resources.

Caves may contain important biological, archaeological, paleontological, hydrological, geological and aesthetic resources, some of which commonly co-occur in individual caves. All of these resources are potentially fragile and are susceptible to damage through uninformed, careless, or unmanaged human activities. Some especially sensitive caves or portions of caves may be managed exclusively for research, with access limited to permitted research personnel.

Research activities may require the sampling of representative materials and/or disturbance of life forms occupying caves. Responsible sampling of one resource, even using the best techniques, has the potential to impact other resources. Archeological and paleontological resources are particularly subject to physical damage or disruption of their contextual character, severely reducing their value for future research. Uninformed or inconsiderate recreational cavers or researchers can damage or destroy invaluable and irreplaceable scientific resources by simply traveling through a sensitive area. Projects for different scientific fields of study should be given equal consideration and weight, and no single field of study should have exclusive priority in cave management and access.

It is the responsibility of the USFS as the steward of these public resources to use the current best management practices in overseeing any research activities in caves on the Forest. Cave research activities must minimize impacts to targeted resources, and collateral damage to non-target resources. The potential value of knowledge to be gained from a given research effort will be reviewed by the Forest Service and balanced against known or potential impacts to cave resources that may result from the proposed research activity. A determination will be made by the Forest Service on the efficacy of the proposed research prior to granting permission and the issuance of appropriate permits to the research proponent. The Forest Service may consult with all available sources of information when evaluating these applications on a case-by-case basis.

Perishable organic materials, including most paleontological and some archeological resources, may be susceptible to degradation over time due to in-situ cave environmental conditions in the cave. These resources need to be evaluated by knowledgeable personnel to determine whether materials will be best conserved by in situ (in place) preservation, or removal and placement in a climate-conditioned public repository.

Effective and responsible management of any natural resource is dependent on detailed knowledge of the resource. Crucial to the management of cave and karst resources on the Forest is knowledge of the presence of caves (where they occur), a detailed understanding of the physical limits of caves (accomplished by survey and mapping of caves), and their hydrologic connectivity with regional water resources. Caves without evident surface expression or human accessible entrances are likely to be present on the Forest. Unknown cave resources could be permanently adversely affected by the alteration of surface or subsurface features resulting from logging, mining, or other ground disturbing development activities. Surface exploration for unknown caves and in-cave exploration for undiscovered areas within known caves are crucial to proper management of cave resources. Cave exploration and other scientific endeavors are thus not competing or mutually exclusive, but complementary disciplines that contribute to the understanding and responsible management of cave and karst resources.

5.4 CAVE SEARCH AND RESCUE (SAR)

On Coconino National Forest, search and rescue is primarily the responsibility of the specific County Sheriff encompassing that particular District.

Key individuals in these rescue organizations will be given the names and numbers of District personnel to contact during rescue operations. Access keys will be solely managed by the Forest and District offices.

District personnel responsible for cave management can provide valuable assistance through knowledge of cave location and layout, access, and resource concerns. Assistance should be provided by cave management personnel through familiarization of S&R techniques, equipment, manpower, and concerns. Recreational cavers that have extensive experience with the caves are also an important resource. They often know specifics of the caves, and of other caves in the area that are relevant to a search management effort. Additional information is available in FSH 2809.15 - MINERALS AND GEOLOGY HANDBOOK. Chapter 25, 3b covers Procedures for Cave Search and Rescue (SAR) and Pre-Planning.

Cave search and rescue operations require personnel with specialized training and equipment. Incident response in the underground environment requires a combination of techniques and gear borrowed from rope rescue, mountaineering, medical, and especially, caving disciplines. In the U.S., cave rescue training is provided by the National Cave Rescue Commission (NCRC), a special commission of the National Speleological Society. The NCRC does not function directly as a rescue unit; it provides training opportunities for individuals and organizations interested in cave rescue. The NCRC offers week-long and weekend trainings throughout the U.S. and also provides additional training when requested. More information on cave rescue can be found at <https://ncrc.info/>.

5.5 CAVE EXPLORATION

Above-ground searching for caves, or ridge walking, is an appropriate use of Forest land and does not require authorization. New and previously unknown portions of caves have been discovered through small digging efforts. Digging, however, has the potential to affect biological, archeological, and paleontological values.

Small activities include developing new or enlarging existing buried entrances that have collapsed. Digging within caves and enlarging existing passages may require authorization by the Forest and/or District offices. Digging within caves and enlarging existing passages may not require authorization if pre-existing agreements are in place.

If archeological artifacts are noted at any time during the enlarging a small hole, **the dig shall stop immediately**, and the Forest Service Archeologist will be notified.

Following an excavation effort to locate a cave entrance, the shape and condition of the original opening should be mimicked so that the air flow change is minimal and wildlife use is not adversely affected. The surface should be maintained by replacing fill material.

Any bolts set for exploration should be placed as sparingly and safely as possible. Stainless steel (non-corrosive) bolts and hangers are required.

5.6 MONITORING

Several monitoring techniques are helpful in the cave management process and allows managers to determine the effectiveness of management methods. An outline of monitoring tools and techniques is presented in [Appendix F – Cave Management Tools and Techniques](#).

Not all techniques are required for all caves, but some caves may require several techniques.

Frequency of monitoring will be based on visitation and sensitivity of resources. In general, caves with a very high visitation should require monitoring once a quarter; Caves with moderate visitation should require monitoring once a year, at a minimum; caves with very low visitation may require monitoring once every few years or as deemed necessary by the District Recreation line officer. It is worth noting that conservation-minded cavers can be of tremendous help in the monitoring process because they are already visiting the cave and are often the most familiar with it. A system should be in place for visitors to the cave to report any observations that may be of interest or importance in the management and/or protection of the resource. A schedule for monitoring caves will be established for each ranger district. Additionally, the Minerals and Geology (M&G) Resource Specialists for the Forest will conduct these monitoring inspections.

5.7 LIMITS OF ACCEPTABLE CHANGE (LAC)

The LAC process identifies the desired condition of a cave resource, defines the amount of change allowed to occur, and establishes the procedures for monitoring and evaluating management performance. (See [Appendix G - Individual Cave Management Files](#)).

LACs may be incorporated into the monitoring of a specific section of a cave. These can be included in the management plan. An example of LAC criteria is "New graffiti will not reach the threshold where it significantly impacts the naturalness of the surroundings".

5.8 GATING CAVES

The decision to gate a cave may be warranted for various reasons (safety, public encroachment, resource sensitivity, species protection, etc.) and should not be taken lightly. If it is determined that a cave gate is needed, it changes the cave's management level. Cave gate related items are included in [Cave Gates](#) and [Cave Trails](#). The Bat Conservation International (BCI) document [Agency Guide to Cave and Mine Gates 2009](#) contains an extensive set of gate construction examples, techniques, and construction material considerations.

Development of [Cave Trails](#) may be used to protect fragile resources. Cave trails can be used to restrict damage to pristine floor surfaces or fragile non-renewable deposits (e.g. bones). Cave trails should be visible and easy to follow. Examples of cave trails currently in use include: rocks lining either side of the path, plastic surveyors' ribbon strung between short PVC stakes lining both sides of the path, and reflective tape on small plastic or aluminum stakes lining both sides of a trail.

An interim closure order for a cave to be gated is needed. Usually, safety and biological comments are helpful in developing a safe gate design that will not deny habitat. Additional considerations are listed in section [5.11 ADAPTIVE MANAGEMENT](#).

5.9 CLEANUP AND RESTORATION PROJECTS

Cave restoration projects usually include litter removal, graffiti removal and speleothem reconstruction. Volunteers are sometimes sought to assist in these projects. However, Forest Service management of these activities is required to ensure historical graffiti and artifacts are not inadvertently removed, and that glues and other chemicals used are not toxic to cave life or human visitors. Cleanup and restoration projects can improve the cave experience, but once non-renewable resources are damaged, they cannot be restored to their original value.

5.10 INDIVIDUAL CAVE MANAGEMENT FILES

Specific management files are developed for caves with high resource, educational or recreational value, hazardous conditions or heavy use. An example of a management file outline is in [Appendix G - Individual Cave Management Files](#). Digital and hardcopy files that are/can be created and, updated, will be stored and managed by the US Forest Service.

5.11 ADAPTIVE MANAGEMENT

Management is adjusted for caves if monitoring (identified in LAC or other processes) indicates that:

1. More restrictive management is needed if unacceptable changes are occurring.
2. Less restrictive management is prescribed because impacts are not adversely influencing resources.
3. A new resource is discovered.
4. Surface conditions change that may impact the cave's management level. For example, a new road going in near the cave entrance.

The District Ranger and/or Forest Supervisor will decide that it is time to re-assign the cave to a new classification and management priority and initiate interim management restrictions (such as a access authorization, seasonal closure, road access or gate) until a management plan is written. Interim management restrictions are just that, interim. Closures and access authorizations need to be placed in the Cave Management Prescription.

Major management adjustments should include the involvement of interested publics.

5.12 KARST MANAGEMENT TECHNIQUES

In order to protect valuable cave resources, while still allowing surface activities to continue, a variety of management techniques can be used. These may be used in different combinations or individual techniques may be altered to produce a more desirable management. A description of common management techniques is presented in [Appendix J - Karst Management](#).

APPENDICIES

Appendix A - Caving Ethics

Caving ethics center on two primary concepts: safety and conservation. Caves have unique scientific, recreational, and scenic values. These values are endangered by both unintentional carelessness and intentional vandalism. Many of these values, once gone, cannot be recovered. The responsibility for protecting caves must be assumed by those who study and enjoy them.

An excellent, free and downloadable document on safe and ethical caving practices is provided by the **National Speleological Society** at [http://caves.org/brochure/Guide to Resp Caving.pdf](http://caves.org/brochure/Guide%20to%20Resp%20Caving.pdf).

Ethical Caving Guidelines

1. Mineral formations (e.g., stalactites, stalagmites, crystals, etc.), and other natural, historical, archaeological, or paleontological specimens of any kind are NOT to be touched, damaged or removed from any cave. The only exception to this policy is through specifically authorized separate research and collection permits approved by the District Ranger or Forest Supervisor. Cave research permitting guidelines are described in **Appendix B - Cave Research Guidelines**. Cave visitors need to consider caves as natural museums and observe, rather than handle, cave resources. Photographs and other non-touching observations that do not harm cave resources are allowed.
2. Due to the potential damage to cave resources and possible asphyxiation of biota and/or human visitors; camping, cooking, smoking, flares, and open fires (other than carbide lamps) are prohibited within Forest caves or near cave entrances. Minimal stove use is allowed when air quality is not a factor, and team health is taken into consideration. For example: in a cold cave, using a stove to heat a warm meal for surveying team members is permitted.
3. Travel paths within caves are confined to non-delicate areas. Cave visitors should stay on established cave trails when available, and every effort should be made to prevent damage to easily trampled cave resources. If it is necessary to travel through areas with thick silt, mud, or delicate speleothems on the floor, cave visitors need to proceed in single file and follow in established foot falls, or trails. Do not climb on formations and stay low with your head kept down in low ceiling areas to prevent damage to formations. Damaging pristine flowstone floors and destruction of speleothem features in "pushing new leads" is prohibited.
4. Individuals are responsible to remove all equipment, supplies, and other materials taken into the cave at the completion of the trip, including carbide residue if carbide lamps are used. Cave registers and travel aids may be left within caves if approved prior to the trip by the District Ranger. Examples of travel aides that could be approved are bolts and pitons (where safe natural riggings are not available) and plastic surveyor's ribbon used to mark trails through delicate areas. Use of flagging tape or other temporary markers as a route-finding tool must be removed before the group leaves the cave.
5. Many cave formations and microclimates are dependent on pristine waters. Water quality and quantity alterations may irreparably damage cave resources and ecosystems. Drinking and/or collecting water from caves is prohibited. Cleaning anything, or the use of soap or detergent (including biodegradable) in any cave water is prohibited. Pack-It-In, Pack-It-Out.

6. Delicate balances within the cave's ecological system may be seriously upset by the introduction of human wastes. Human waste, both solid and liquid, must be carried out of the cave and properly disposed of outside the cave well away from the cave entrance. Use of “pee bottles and WAG bags” or similar waste containment is mandatory.
7. Caving groups should be kept to a minimum of two (2) and a maximum of six (6) persons in “Restricted Access” caves. Larger group sizes may be allowed if determined in a specific cave management prescription. Larger groups may have difficulty moving through delicate areas without damaging cave resources.
8. A minimum group size of three individuals is recommended in all caves.
9. No gum or tobacco is to be used within caves. No spitting is allowed. These items allow the introduction of foreign microorganisms into the cave environment resulting in an alteration of the native environment.
10. Gloves should be worn in cave environments as the oils in skin may kill any active growth of cave speleothems (features).
11. Do not disturb bats, or other wildlife. This causes them to use and waste valuable energy that would otherwise be used to sustain them during critical non-active periods.
12. Pets will not be allowed into caves.
13. When going into caves in more than one area, caving equipment, boots and clothing should be cleaned, washed and disinfected to avoid transporting microbes and other materials from one region to another.

Safety Considerations

These are some minimum safety considerations to be aware of and follow:

1. A minimum group size of two individuals is recommended in all caves.
2. Before the trip always tell someone:
 - Where the group is going
 - When the group is expected to return
 - Contact the person when the group is out of the cave
3. Each person should:
 - Wear a helmet with a chin strap
 - Carry three lights, including one light mounted on the helmet, and extra batteries.
 - Wear boots with good traction
 - Carry enough food and water for the day.
4. Areas in caves with steep drop offs can require ropes. Special training and equipment are needed to be able to safely go down **and come back up**. Training is available through caving organizations such as the National Speleological Society at <https://www.caves.org>
5. Knee pads and elbow pads are recommended

Appendix B - Cave Research Guidelines

The following guidelines will be incorporated into research permits as applicable:

- All research conducted within the Forest requires the submission of a written proposal and subsequent approval from the appropriate District Ranger or designated cave management resource specialist. The USFS may solicit the assistance of outside specialists in various disciplines in the vetting of cave researchers and proposal analysis. Approval to conduct research within Forest Significant caves will be made on a case-by-case basis after USFS review and acceptance of the research proposal. Proposals must justify the need for the collection of specimens or sampling of other cave resources. Additionally, all information obtained as part of the Forest Service approved research will be shared with the Forest Service will include, at a minimum, a final report provided to the Forest as well as all analytical data generated as part of the research undertaking. Specimens removed from Forest Significant caves as part of research efforts shall be repatriated where feasible and appropriate to the source cave upon completion of research activities or shall ultimately be placed in a suitable public repository capable of proper curation and permanent housing of the specimens. A uniquely numbered USFS scientific collecting permit must be obtained by the proponent prior to initiating any sampling within caves.
- Researchers will use non-consumptive techniques wherever possible. If it will be necessary to alter or damage cave resources in order to obtain useful scientific data, the researcher is required to include an assessment of the potential for and/or level of resource impacts anticipated from the research in the proposal. The researcher must evaluate the extent to which the research may individually affect cave resources.
- Researchers will demonstrate, through verifiable experience, competency for working in the cave environment. This is important for both the safety of research team members and for the conservation of resources. Researchers without prior or adequate in-cave experience may be accompanied by a Forest Service representative at the discretion of the District Ranger. To minimize collateral damage to cave resources, in-cave research teams will include only those personnel necessary to accomplish research goals. This may include a Forest Service representative at the discretion of the agency. The in-cave research team will be adequately briefed on cave conservation techniques and known and potential resources occurring in the project cave(s). Researchers must stay within limits of designated in-cave trails where they are established, unless permission to visit other areas is permitted by the USFS. Researchers and their team are subject to the Caving Ethics policy outlined in [Appendix A - Caving Ethics](#). All in-cave team members will sign the cave permit issued to the researcher. The principal investigator is responsible for the actions of the entire party.
- The USFS encourages peer-reviewed journal publication of scientific findings resulting from cave research conducted on the Forest. However, because of the sensitivity of many resources present in Forest caves, the names and locations of some caves are considered proprietary. Researchers must receive guidance from the Forest Service regarding the level of location information that is appropriate for dissemination for each cave mentioned in scientific papers. A USFS sensitive information disclosure review of all manuscripts resulting from research

conducted on Forest lands is required prior to submission for publication. The Forest Service will be cited in all scientific papers.

- As a precautionary measure to minimize the potential for the spread of White Nose Syndrome in bats into Arizona, researchers must comply with current U.S. Fish and Wildlife guidelines regarding this issue. Any changes in guidelines or protocols that may be instituted during the life of a permitted research activity will automatically require compliance by cave researchers.
- Research activities must not alter or remove materials from any cave that will result in degradation of a cave without specific written approval.
- Research conducted within Forest caves will not be allowed to result in the depletion of any cave resource. During the proposal review process the Forest Service will consider the potential for future technologies that might accomplish research goals with reduced overall impact to target and/or other cave resources. Every effort will be made to avoid unnecessary publicity or advertisement that could result in increased cave visitation or vandalism, and precipitate otherwise unnecessary salvage operations.
- Because research provides valuable information that supports management of Forest cave resources and may be instituted to evaluate resources or resolve questions regarding impacts to these resources, research will generally take precedence over recreational use of caves. Such decisions are at the discretion of the District Ranger. If a researcher anticipates conflicts with recreational caving, a temporary closure of the cave may be requested for the period during which field research will be taking place. Typically, this period shall not exceed 90 days unless previously approved by an Authorized Officer. During this time frame only the research group will be given permission to visit the cave. Extensions of the closure exceeding 90 days may be granted, provided progress reports indicate a longer closure is necessary. At the end of the closure, the researcher must ensure that no cave resources are more vulnerable than they were prior to the research activities (e.g., new trails leading to the cave, publicity about the cave's location, open excavations within the cave, etc.).
- Static cave resources such as archeological, mineralogical or paleontological materials that will be moved, altered, or removed for research purposes will be photographed in-situ with an included scale prior to alteration or removal. Multiple photographs that show the relationship of such resources within the context of the undisturbed condition (position) of the object(s) will be taken such that reference points within the cave may be relocated. To ensure that the original location of removed resources can be accurately relocated, the location will be referenced to an unobtrusive permanent survey station or other recoverable, permanent reference point in the cave. Additionally, the original location of the resource may be plotted on an existing map of the cave.
- The Forest Service may require that a Forest Service representative accompany research activities in some caves.

Other specific conditions may be added as necessary for individual research or collecting permits.

Recommendations for Cave and Karst Management

Example – Scientific Research and Collecting Permit

Scientific Research and Collecting Permit Grants Permission in accordance with the attached general and special conditions. White River National Forest	Study #: Permit #: Start Date: Expiration Date: Partner Agreement #: Operational Code:
---	---

Principal Investigator:
Name: _____ Phone: _____ Email: _____

Institute Represented:
Name: _____

Additional Investigators and/or Assistants:

Name: _____ Phone: _____ Email: _____

Name: _____ Phone: _____ Email: _____

Name: _____ Phone: _____ Email: _____

Name: _____ Phone: _____ Email: _____

Name: _____ Phone: _____ Email: _____

Study Title:

Purpose of Study:

Subject / Discipline:

Locations Authorized:

Transportation Method to Research Site:

Collection of the following specimens or materials, quantities, and any limitations on collecting:

Name of repository for specimens or sample materials (if applicable):

In addition to the [General Conditions](#) for Scientific Research and Collecting Permit, the following specific conditions or restrictions, and any attached conditions also apply to this permit.

1. Notify the permit coordinator approximately two weeks prior to field work.
2. Researchers must comply with all local, state and federal laws. The [Code of Federal Regulations, Title 36](#), provides a complete listing of rules and regulations applicable to all USFS areas.
3. Vehicles must stay on existing public roads and obey any road closures.
4. Researchers are responsible for their own safety and should be knowledgeable about traveling and route finding through cave environments.
5. Carry a copy of this permit with you in the field.
6. If collections of specimens is approved, and if specimens will not be destroyed in analysis, the researcher must coordinate the return of properly prepared specimens prior to collection.
7. Specimens collected under a research permit may be used only for scientific or educational purposes. Any components of specimens and the research derived from them, may not be used for commercial or revenue generating purposes unless a Cooperative Research and Development Agreement or other sharing agreement has been approved by the USFS Washington Office.
8. Submit copies of field notes, including the location of species collection (to the nearest cave survey marker) and research areas within 30 days of conducting field work.
9. Submit an Investigators Annual Report (IAR) by December 15th of each year of research.
10. Copies of all publications, posters, and/or reports using data collected on USFS Forest Districts must be submitted to the District research permit coordinator within two months of publication.
11. Disturbance of in-cave water sources is only allowed when specified in the research permit.
12. Unmanned Aircraft Systems (UAS) or drones are only allowed when specified in the research permit. All USFS UAS regulations must be followed.
13. Proper adherence to all current WNS decontamination procedures is required without exception.
14. This permit is not a substitute for USFS District level cave access protocols. A separate cave access registration may be required prior to entry of any cave.

Summary of permitted field methods and activities:

Recommended by USFS Staff:

Name: _____ Title: _____ Date _____

Approved by USFS Official:

Name: _____ Title: _____ Date _____

I Agree to All Conditions and Restrictions of this Permit As Specified

(Not valid unless signed and dated by the principal investigator.)

(Principal investigator)

(Date)

THIS PERMIT AND THE ATTACHED CONDITIONS AND RESTRICTIONS MUST BE CARRIED AT ALL TIMES WHILE CONDUCTING THE ABOVE DESCRIBED RESEARCH ACTIVITIES IN THE LOCATIONS AUTHORIZED.

Recommendations for Cave and Karst Management

General Conditions for Scientific Research and Collecting Permit

1. **Authority** - The permittee is granted privileges covered under this permit subject to the supervision of the superintendent or a designee, and shall comply with all applicable laws and regulations of the United States Forest Service (USFS) area and other federal and state laws. A USFS representative may accompany the permittee in the field to ensure compliance with regulations.
2. **Responsibility** - The permittee is responsible for ensuring that all persons working on the project adhere to permit conditions and applicable USFS regulations.
3. **False Information** - The permittee is prohibited from giving false information that is used to issue this permit. To do so will be considered a breach of conditions and be grounds for revocation of this permit and other applicable penalties.
4. **Assignment** - This permit may not be transferred or assigned. Additional investigators and field assistants are to be coordinated by the person(s) named in the permit and should carry a copy of the permit while they are working in the cave. The principal investigator shall notify the appropriate USFS District Research and Collecting Permit Office when there are desired changes in the approved study protocols or methods, changes in the affiliation or status of the principal investigator, or modification of the name of any project member.
5. **Revocation** - This permit may be terminated for breach of any condition. The permittee may consult with the appropriate USFS Regional Science Advisor to clarify issues resulting in a revoked permit and the potential for reinstatement by the Forest Supervisor or a designee.
6. **Collection of Specimens** (including materials) - No specimens (including materials) may be collected unless authorized on the Scientific Research and Collecting permit.

The general conditions for specimen collections are:

- Collection of archeological materials without a valid Federal Archeology Permit is prohibited.
- Collection of federally listed threatened or endangered species without a valid U.S. Fish and Wildlife Service endangered species permit is prohibited.
- New specimens must be reported to the USFS annually or more frequently if required by the district issuing the permit. Minimum information for annual reporting includes specimen classification, number of specimens collected, location collected, specimen status (ie; herbarium sheet, preserved in alcohol / formalin, tanned and mounted, dried and boxed, etc.), and current location.
- Collected specimens that are not consumed in analysis or discarded after scientific analysis remain federal property. The USFS reserves the right to designate the repositories of all specimens removed from the cave and to approve or restrict reassignment of specimens from one repository to another. Because specimens are Federal property, they shall not be destroyed or discarded without prior USFS authorization.
- Each specimen (or groups of specimens labeled as a group) that is retained permanently must bear USFS labels and must be accessioned and cataloged in the USFS National Catalog. Unless exempted by additional forest-specific stipulations, the permittee will complete the labels and catalog records and will provide accession information. It is the permittee's responsibility to contact the USFS for cataloging instructions and specimen labels as well as instructions on repository designation for the specimens.
- Collected specimens may be used for scientific or educational purposes only, and shall be dedicated to public benefit and be accessible to the public in accordance with USFS policies and procedures.
- Any specimens collected under this permit, any components of any specimens (including but not limited to natural organisms, enzymes or other bioactive molecules, genetic materials, or seeds), and research results derived from collected specimens are to be used for scientific or educational purposes only, and may not be used for commercial or other revenue - generating purposes unless the permittee has entered into a Cooperative Research And Development Agreement (CRADA) or other approved benefit

Recommendations for Cave and Karst Management

- sharing agreement with the USFS. The sale of collected research specimens or other unauthorized transfers to third parties is prohibited. Furthermore, if the permittee sells or otherwise transfers collected specimens, any components thereof, or any products or research results developed from such specimens or their components without a CRADA or other approved benefit-sharing agreement with PS, permittee will pay the USFS a royalty rate of twenty percent (20%) of gross revenue from such sales or other revenues. In addition to such royalty, the USFS may seek other damages to which the USFS may be entitled including but not limited to injunctive relief against the permittee.
7. **Reports** - The permittee may be required to submit an Investigator's Annual Report (IAR) and copies of final reports, publications, and other materials resulting from the study. Instructions for how and when to submit an annual report will be provided by USFS staff. USFS research coordinators will analyze study proposals to determine whether copies of field notes, databases, maps, photos, and/or other materials may also be requested. The permittee is responsible for the content of reports and data provided to the USFS.
 8. **Confidentiality** - The permittee agrees to keep the specific location of caves and sensitive cave resources confidential. Sensitive resources include threatened species, endangered species, and rare species, archeological sites, caves, fossil sites, minerals, commercially valuable resources, and sacred ceremonial sites.
 9. **Methods of Travel** - Travel within USFS lands is restricted to only those methods that are available to the general public unless otherwise specified in additional stipulations associated with this permit.
 10. **Other Permits** - The permittee must obtain all other required permit(s) to conduct the specified project.
 11. **Insurance** - If liability insurance is required by the USFS for this project, documentation must be provided that it has been obtained and is current in all respects before this permit is considered valid.
 12. **Mechanized Equipment** - No use of mechanized equipment in designated, proposed, or potential wilderness areas is allowed unless authorized by the superintendent or a designee in additional specific conditions associated with this permit.
 13. **USFS Participation** - The permittee should not anticipate assistance from the USFS unless specific arrangements are made and documented in either an additional stipulation attached to this permit or in other separate written agreements.
 14. **Permanent Markers and Field Equipment** - The permittee is required to remove all markers or equipment from the field after the completion of the study or prior to the expiration date of this permit. The superintendent or a designee may modify this requirement through additional cave specific conditions that may be attached to this permit. Additional conditions regarding the positioning and identification of markers and field equipment may be issued by the USFS for individual caves.
 15. **Access to closed or restricted areas** - Approval for any activity is contingent on the cave being open and staffed for required operations. No entry into restricted areas is allowed unless authorized in additional cave specific stipulations attached to this permit.
 16. **Notification** - The permittee is required to contact the appropriate USFS Research and Collecting Permit Office (or other offices if indicated in the stipulations associated with this permit) prior to initiating any fieldwork authorized by this permit. Ideally this contact should occur at least one week prior to the initial visit to the cave.
 17. **Expiration Date** - Permits expire on the date listed. Nothing in this permit shall be construed as granting any exclusive research privileges or automatic right to continue, extend, or renew this or any other line of research under new permit(s).
 18. **Other Stipulations** - This permit includes by reference all stipulations listed in the application materials or in additional attachments to this permit provided by the superintendent or a designee. Breach of any of the term of this permit will be grounds for revocation of this permit and denial of future permits.

Appendix C – Cave Evaluation and Classification Guidelines

This section provides guidelines and information for cave evaluations for Significant Cave nominations. The Significant Cave nomination guidelines are in [Appendix D – Significant Cave Designation Process](#). The nomination worksheet is located at [USFS Significant Cave Nomination Worksheet](#).

Note: When performing periodic cave inventories including impact assessments, use the [Appendix E - General Inventory Procedures](#).

FSM 2356.03 states that caves are to be classified so they can be managed to address the identified cave resource values. Note that Class definitions have been developed independently and vary between USFS Regions and Forests. Cave Classes may be changed due to, for example, new discoveries being made or research information becoming available.

All caves on the Coconino National Forest should be evaluated using the rating system described below. The Cave Classification (Directed Access, Non-Active Management, Active Management, Restricted Access, Closed and Newly Discovered) is determined by the Cave Evaluation Guidelines, which assign values to various cave resources. The assigned values will be used in determining the cave’s Class and making management decisions. The evaluation values will help in making determinations of a cave’s significance per the Federal Cave Resources Protection Act of 1988 (FCRPA). If a cave has a Cave Rating Evaluation of "Moderate" or greater, in one or more categories, the cave will be considered for designation as significant using the criteria in 36 CFR 290.3(c) and (d) (FCRPA Implementation Regulations 1994).

The five cave management Classes are grouped in part on the cave evaluations, and with respect to similar areas of cave management. As new caves are discovered they will be temporarily managed as **CLASS 4 or CLASS 5** until an analysis of the resource values is completed.

CLASS	CAVE CLASS EXPLANATION
CLASS 1	DIRECTED ACCESS CAVES: Caves with directed access for public use. These caves are on maps and may have signs directing visitor access. These caves may have guided tours and possibly artificial lighting. Regardless of any level of development, public visitation is encouraged. These caves do not have unique hazards to human use and may be suitable for use by the general public. Cave information may be provided and may include directions to the cave. Fulford Cave is one such example.
CLASS 2	NON-ACTIVE MANAGEMENT CAVES: Caves that are undeveloped but are suitable for recreational exploration by persons who are properly prepared. These caves include the vast majority of the caves on the White River National Forest. In general, these caves contain resources that resist degradation by moderate levels of recreational use. Public attention will not be directed toward these caves. Some features/biological resources may be present, but some level of impact will be accepted. Some of these caves will be monitored to determine if any negative effects are occurring over time.

Recommendations for Cave and Karst Management

<p>CLASS 3</p>	<p>ACTIVE MANAGEMENT CAVES: Caves that have sensitive features and/or severe safety hazards, but may be entered without significant adverse impacts or undue danger by properly equipped and experienced cavers. These caves include caves with gates, caves having seasonal closures for biota (e.g. bats), or caves having special access restrictions for reasons such as cultural material sensitivity. There will be a range of management objectives in these caves. Individual cave management prescriptions are encouraged. The number of visits may be limited per month for caves with sensitive features. For groups wishing to enter caves with extreme safety hazards, the Forest may request that the group have adequate caving/climbing skills. The cave access authorization system may also serve as a monitoring tool.</p>
<p>CLASS 4</p>	<p>CLOSED AND RESTRICTED ACCESS CAVES: Caves that have extremely sensitive physical, biological, cultural or paleontological resources. Access to these caves will be via special access authorization and agreements. Individual cave management prescriptions are required. They may become part of a sample of caves that might serve as a baseline for undisturbed conditions.</p>
<p>CLASS 5</p>	<p>NEWLY DISCOVERED CAVES: Caves that have been recently discovered and yet to be thoroughly evaluated. Newly discovered caves, by definition, represent the entire spectrum of caves. The discovering team will be making initial judgements as they go in, making decisions as to the cave's well-being and minimizing impacts as they proceed. By default, the original discoverers are the initial cave managers and may help determine into which CLASS the cave may be placed. Newly discovered caves may be nominated for significant cave status under the procedures provided in the CFR Title 43 CFR § 37.11 - Nomination, evaluation, and designation of significant caves. Further information on this process is found in Appendix D of this document.</p>

Information concerning the location of caves will be kept confidential in accordance with the provisions of FRCPA. Only the locations of caves designated as Directed Access will be made available to the public.

Evaluation and monitoring of all caves will be the sole responsibility of the Forest Service and may include other interested parties' participation in the process on a case-by-case basis. Experienced cavers are encouraged to participate in the evaluation and monitoring process.

Cave classification is the first step in cave management. Caves are placed into one of the classes described above based on management objectives consistent with identified cave resource values, sensitivity level (exposure to destructive impacts) and Limits of Acceptable Change (LAC). As new caves are discovered, they are temporarily managed as Significant until an analysis of resource values is determined. The Cave Evaluation Guidelines listed below are in accordance with the FCRPA Significant Cave Nomination Process. The Significant Cave Nomination Process worksheet (see Appendix D) provides further guidelines.

Cave Evaluation Guidelines

All caves will be evaluated using the following rating system. The system allows values of Low (L), Moderate (M) and High (H) to be assigned to various cave resources. The assigned values will be used to determine cave classification and will be used in determining cave significance under the implementation regulations of the Federal Cave Resources Protection Act of 1988.

There are two sets of ratings. These are the **Resource Value Level** and the **Sensitivity Level** in that Resource area. The Resource Levels (Low, Moderate, and High) have guidelines for interpretations. Additional Sensitivity Level wording to help interpretations follows below. The question comes down to “How extensive is the resource and how sensitive is it to disturbance?”

BIOLOGICAL RESOURCES

VALUE	EXPLANATION OF VALUE
L	Biological components lacking or of low apparent significance.
M	Biological components present and numerous, with low to moderate sensitivity.
H	Biological components numerous and highly sensitive to disturbance. Habitat is critical to species survival. The cave contains unique species, or ones found on State or Federal sensitive, threatened, or endangered species lists.

CULTURAL / HISTORIC RESOURCES

VALUE	EXPLANATION OF VALUE
L	Cultural resources lacking and/or with low potential.
M	Potential for cultural resources moderate or implied by historical records. Site may be eligible for the National Register of Historic Places.
H	Cultural resources present and sensitive to disturbance. Site eligible for the National Register of Historic Places.

GEOLOGICAL / MINEROLOGIC / PALEONTOLOGICAL VALUE

VALUE	EXPLANATION OF VALUE
L	Features of significance lacking with some interesting features present.
M	Features present with a moderate sensitivity to disturbance.
H	Features rare, valuable, numerous and of high value. Features are sensitive to disturbance.

HYDROLOGY

VALUE	EXPLANATION OF VALUE
L	Hydrologic components lacking and of low importance.
M	Hydrologic components present but of low to moderate sensitivity.
H	Hydrologic components important, complex and very sensitive.

RECREATIONAL VALUE

VALUE	EXPLANATION OF VALUE
L	Cave lacks recreational value with little or no scenic appeal. Characteristics are such that a return trip would not be warranted.
M	Recreational value is low but receives moderate use/visitation. Scenic values are low to moderate.
H	Recreational values, scenic values and are use high. A major cave of regional or National significance.

EDUCATIONAL OR SCIENTIFIC VALUE

VALUE	EXPLANATION OF VALUE
L	Caves lacking educational or scientific value.

Recommendations for Cave and Karst Management

M	Caves with features that can be used for educational or scientific study but are otherwise considered common to the area.
H	Caves providing unusual or unique opportunities for interpretation and educational or scientific study.

CAVE SENSITIVITY LEVELS:

1. **LOW:** There is very little if any of the above resources present. If the resource is present, it is located away from frequently visited areas. Significant effort is required to locate the resource, making threats less likely.
2. **MODERATE:** The resource is located on or near frequently visited areas and routes. Inadvertent impact to the resource is likely. Examples include pottery shards located along an in-cave trail, a bat roost beyond a low crawlway that would deter most casual explorers, or historic signatures within easy access to frequented trails.
3. **HIGH:** The resource is prevalent and sensitive to disturbance and significant in nature. A conscious effort is required by visitors to avoid impacting the resource. Advanced planning/discussion is necessary prior to arriving at the sensitive area. Knowledgeable, conservation minded trip leaders, trip size limits, access limitations and other management techniques may apply.

CAVE RATING SUMMARY

CAVE RATING SUMMARY	
(For determining Cave's Significance and Classification)	
CAVE NAME: _____	EVALUATED BY: _____
CAVE INVENTORY #: _____	DATE: _____
DISTRICT: _____	CAVE CLASS: _____
LEGAL*: _____	
* Cave is located in a special management area. Examples include: Area of Critical Environmental Concern (ACEC). Wilderness. National Natural Landmark. Most of the time the field will be 'none'.	

	Biological (B)	Cultural (C)	Geologic/Mineralog ic/Paleontological (G,M,P)	Hydro logic (H)	Recreational (R)	Education or Scientific (E,S)	Safety-Hazard (HAZ)
Resource Level L, M, H							
Sensitivity Level L, M, H							

Appendix D – Significant Cave Designation Process

The Federal Caves Resources Protection Act of 1988 requires that the Forest Service identify all significant caves on National Forest System Lands.

Although there are many definitions for a cave, the 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 and which is large enough to permit a person to enter, whether the entrance is excavated or naturally formed.”

What is a Significant Cave?

It is the intent of the Act that significant caves include all caves that have one or more of the following values:

- Biological
- Cultural
- Geological/Mineralogical/Paleontological
- Hydrological
- Recreational
- Educational/Scientific
- Specially Designated Areas

The term Significant was added to provide a filter so that Federal agencies would not be required to "manage every little hole in the ground" and to leave out cave like features containing "... no resources of any interest to anyone or any recognizable natural resource value"

Resource - Criteria of Significance

Considerations as to “What is “Significant?” are subjective in determining whether the criteria of an FCRPA area of Significance is met. The following checklists are offered as criteria to consider when evaluating the value of the cave resource.

Cave Resource Areas: (more than one may apply):

Biology (B):

The cave provides seasonal or yearlong habitat

- Flora/fauna native to caves
- Species sensitive to disturbance
- State/Federal Sensitive, Threatened or Endangered
- Bats – lots of bats, T&E bats, maternity/hibernacula, etc.
- Macroscopic biota (vertebrates and invertebrates), T&E species
- Microscopic biota (E.g. microbe mats)
- Includes use by surface animals (dens, roosts)

Cultural (C):

The cave contains historical sites, archeological resources or other features of importance

- Research potential that is important for history/prehistory
- Historical associations

- Historical or traditional significance
- Human remains
- Pre-historic cultural artifacts
- Historic cultural artifacts

Geological/Mineralogical/Paleontological (G,M,P):

- Geologic or mineralogic features that are fragile, that exhibit interesting formation processes, or that are otherwise useful for study.
- Deposits of sediments or features that are useful for evaluating past events.
- Paleontologic resources with potential to contribute useful education & scientific information.
- Paleontologic animal remains
- Mineralogy (formations)
- Cave formations (various types) subjective

Hydrological (H) (caves with water):

- The cave is a part of a hydrologic system or contains water that is important to humans, biota, or the development of cave resources.
- Caves with streams
- Aquifer conduits (caves taking in water)
- Aquifer conduits (caves discharging water)
- Standing pools

Recreational (R):

- The cave provides or could provide recreational opportunities or scenic values.
- Total length, volume, depth, pit depth, height, or similar features are notable
- Would someone return on another trip?
- Would someone recommend the cave for others to visit?

Educational or Scientific (E,S):

- Offers opportunity for educational or scientific use
- Cave is in a pristine state; lacks human evidence

Another set of items to consider are Hazards:

- Very unstable passage (ceilings, breakdown)
- Bad air
- Prone to flooding
- Regular use by dangerous or poisonous animals

Specially Designated Areas:

All caves located within special management areas, such as Special Geologic Areas, Research Natural Areas, or National Monuments that are designated wholly or in part due to the cave resources found therein are determined to be USFS Significant Cave Nomination Worksheet.¹²

¹² Limaris Soto, National Caves and Karst Program Lead, USFS

USFS Significant Cave Nomination Worksheet



SIGNIFICANT CAVE NOMINATION WORKSHEET (Reference FSM 2880)

FS- 2800-0023 (Rev. 12/2021)
OMB# 0596-0246
Exp. 12/31/2024

To Be Filled Out by the Person or Organization Submitting this Nomination

Name _____

Address _____ / _____ / _____
Street City State & Zip

Telephone # (____) _____ Email _____ Date _____
(MM/DD/YYYY)

Person to contact for additional information:

Name _____ Telephone (____) _____

Nomination Information

Cave Name _____

Location: State: _____ Meridian: _____ Town: _____ Range: _____ Section: _____
Abbreviation Ex. DC

OR GPS Coordinates:

Lat. _____ Long. _____ Format. _____

Position Error/ # of Satellites _____

Coordinate System _____

OR Verbal description:

* Topographic Map Enclosed: Yes No *Cave Map Enclosed: Yes No

Administering Federal Agency: _____

Local field office where cave is located: _____

* Information marked with an (*) is considered **confidential** under (section 5, Federal Cave Resources Protection Act, 1988) and is not subject to public disclosure under the Freedom of Information Act (Section 552 of Title 5 U.S. Code).

A cave must meet one or more of the following criteria to be eligible for designation as a significant cave. If you select "yes" for one or more of these criteria, please explain why in the remarks section. If desired, you may attach additional materials that will support your conclusions.

YES NO **Biota:** The cave provides seasonal or year-long habitat for organisms or animals; contains species or subspecies of flora or fauna native to caves; are sensitive to disruption; or are found on State or Federal sensitive, threatened, or endangered species lists.

Remarks:

YES NO **Cultural:** The cave contains historic properties or archaeological resources or other features that are included in, or eligible for, inclusion in the National Register of Historic Places because of its research importance for history or prehistory, its historical associations, or other historical or traditional significance.

Remarks:

YES NO **Geologic/Mineralogic/Paleontologic:** The cave possesses one or more of the following features:

- (1) Geologic or mineralogic features that are fragile, or that exhibit interesting formation processes, or that are otherwise useful for study.
- (2) Deposits, sediments, or features useful for evaluating past events.
- (3) Paleontological resources with potential to contribute useful educational and scientific information.

Remarks:

YES NO **Hydrologic:** The cave is a part of a hydrologic system or contains water that is important to humans, biota, or development of cave resources.

Remarks:

YES NO **Recreational:** The cave provides or could provide recreational opportunities or scenic values.

Remarks:

Recommendations for Cave and Karst Management

FS-2800-0023 (REV. 12/2021)

YES NO **Educational or Scientific:** The cave offers opportunities for educational or scientific use; the cave is virtually in a pristine state, lacking evidence of contemporary human disturbance or impact; or the length, volume, total depth, pit depth, height, or similar measurements are notable.

Remarks:

YES NO **Specially Designated Area:** All caves located within special management areas, such as Special Geologic Areas, Research Natural Areas, or National Monuments that are designated wholly or in part due to the cave resources found therein are determined to be significant.

Remarks:

Additional Comments:

Attach Sketch

According to the Paperwork Reduction Act of 1995, an agency may not conduct or sponsor, and a person is not required to respond, to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0596-0246. Response to this collection of information is mandatory. The authority to collect the information is the The Federal Caves Resources Protection Act of 1988 and 36CFR § 290.5 cites. The time required to complete this information collection is estimated to average 11 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its Agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, gender identity (including gender expression), sexual orientation, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident.

Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the responsible agency or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the Federal Relay Service at (800) 877-8339. Additionally, program information may be made available in languages other than English.

To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at How to File a Program Discrimination Complaint and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by: (1) mail: U.S. Department of Agriculture, Office of the Assistant Secretary for Civil Rights, 1400 Independence Avenue, SW, Washington, D.C. 20250-9410; (2) fax: (202) 690-7442; or (3) email: program.intake@usda.gov.

USDA is an equal opportunity provider, employer, and lender.

The Privacy Act of 1974, 5 U.S.C. 552a and the Freedom of Information Act, 5 U.S.C. 552 govern the confidentiality to be provided for information received by the Forest Service.

File Code: 2880

For technical questions and Section 508 accommodation, please contact fseforms@fs.fed.us

Page 3 of 3

Significant Cave Finding/Decision¹³

Name of Cave: _____

Forest Service Cave Identification Number: _____

Background: The Federal Cave and Resources Protection Act of 1988 (16 U.S.C. 4301-4309) directs the Secretary of Agriculture to prepare and maintain a listing of significant caves. The criteria for listing of significant caves in 36 Code of Federal Regulations Part 290. To qualify for listing as a significant cave, a cave must meet one or more of the criteria.

Finding/Decision: After careful review of the information submitted with the nomination, it is my finding that _____ Cave:

_____ Qualifies for listing as a significant cave. It meets the following criteria:

- _____ Biota
- _____ Cultural
- _____ Geologic/Mineralogic/Paleontologic
- _____ Hydrologic
- _____ Recreational
- _____ Educational/Scientific
- _____ Specially Designated Area

_____ Does not qualify for listing as a significant cave.

Comment: _____

As prescribed in 36 CFR, Part 290.3(g) this decision is not subject to further administrative appeal.

Forest Supervisor

Date

Role of the Authorized Officer

- Receives listing recommendations from internal staff and partners.
- Verifies questionable data relevant to the evaluation process by consulting with the nominator, internal staff, or consultants. The nomination may be returned to the applicant for more information if there is inadequate information from which to make the listing decision.
- Makes final listing decision.
- Notifies nominator and internal staff of finding.
- Returns all nomination materials to originator for caves not determined to be significant.
- Maintains a log for tracking of each nomination.
- Transmits a copy of the log to the Regional Cave and Karst Program Lead
- Takes necessary measures to ensure the confidentiality of cave information.

¹³ Limaris Soto, National Caves and Karst Program Lead, USFS
Editor's note - Reformatted from original to fit the bounds of this document. No part of the content has been changed.

Recommendations for Cave and Karst Management

- Provides for interim protection of significant caves until they can be incorporated in the agency Land and Resource Management Plan.
- Ensures that significant caves are scheduled for inclusion in the agency Land and Resource Management Plan.

Appendix E - General Inventory Procedures

Table 3 lists information needed to populate INFRA and should be collected and maintained for each cave. Master file and Public file information guidelines for confidentiality are in [Appendix G - Individual Cave Management Files](#).

Table 3: Information to be Maintained as Part of Each Cave File.	
Cave Name	Township, Range, Section, Quadrant
Cave Number (entrance number)	USGS Quadrangle Number
Significant? YES / NO Date: _____	Cave Classification: 1. Directed Access, 2. Non-Active Management, 3. Active Management, 4. Restricted Access and Closed, 5. Newly Discovered
Date Marker Cap Set	Special Management Concerns
Cave Length	Descriptive Notes
Latitude of entrance WGS84 (D.ddddd or UTM):	Cave marked on Air Photo Overlay
Longitude of entrance WGS84 (D.ddddd or UTM):	Cave location on a USGS 7 1/2 minute 1:24,000 topographic map
Elevation of entrance	Cave Map (if not mapped, a sketch should be provided)
Person Supplying Data, and Date	
Pattern of Cave (maze/horizontal/pit/dendritic)	Type of Entrance. Azimuth of entrances looking out.
Vertical Relief	Number of Entrances
Number of Levels	Photos of Entrances and Representative Passages
Water Elements	Cave Map (Yes or No)
Hazards	Special Equipment Needed
Special Skills Required	Type of Protection Needed
Cave Contents	Geologic Formation
Rock Type	Type of Cave
Categories of Significance satisfied: Geological, biological, scientific, archeological, historical, cultural and educational values	Photos of Entrance and Representative Passages
Research: References to research done in the cave	restrictions on information dispersal
Cave History if Known	Restrictions on information dispersal

Recommendations for Cave and Karst Management

Inventory Lead _____ Phone () _____ Email _____ Miles _____ Hours _____ Miles: round trip. Hours: driving, time contributing on task. Do not count evenings/sleep.	
Name _____ Miles _____ Hours _____	Name _____ Miles _____ Hours _____
Name _____ Miles _____ Hours _____	Name _____ Miles _____ Hours _____

Appendix E - General Inventory Form

All persons involved in inventory should be aware of the spectrum and fragility of cave resources on the Forest so that these resources are not inadvertently damaged. Inventory workers will abide by "caving ethics" (**Appendix A - Caving Ethics**) and should also be aware of other known caves in the area so that these are not re-inventoried. Inventory work will be managed by a Forest Service employee with cave coordination responsibilities. Assistance may come from local cave management partner organizations, volunteers and other stakeholders.

Information concerning the location of caves will be kept confidential in accordance with provisions of the FCRPA (FCRPA §5, 36 CFR §290.4, FSM 2356.2 [1]).

A file of permanent data will be maintained for each cave. This file will remain locked, with access provided on a need-to-know basis and signed agreements.

Table 3 lists information needed to populate INFRA and should be collected and maintained for each cave. Master file and Public file information guidelines for confidentiality are in **Appendix G - Individual Cave Management Files**. Master file and Public file information guidelines for confidentiality are in Appendix G - Individual Cave Management Files.

Date of Inventory: _____ Phone: _____ Email: _____

Inventory Lead: _____ **Miles:** _____ **Hours:** _____

Others Helping:

Name(s):	Name(s):	Name(s):
Miles _____ Hours _____	Miles _____ Hours _____	Miles _____ Hours _____

(**Miles:** round trip. **Hours** include driving, time contributing on task. Do not count sleep and evenings.)

Table 3: Information to be Maintained as Part of Each Cave File.	
Cave Name:	Township, Range, Section, Quadrant:
Cave Number:	USGS Quadrangle Number:
Significant? YES / NO	Cave Classification: Directed Access, Non-Permit, Permit, Preserve:
Date Marker Cap Set:	Special Management Concerns:
Cave Length (estimate if needed):	Descriptive Notes:
Lat/Long: WGS84 (Decimal Degrees D.ddddd) or UTM coordinates:	Cave location marked on Air Photo Overlay:
N _____ W _____	Cave location on a USGS 7 1/2 minute 1:24,000 topographic map:
Elevation of entrance:	Cave Map (if not mapped, a sketch should be provided) :

Recommendations for Cave and Karst Management

Vandalism/Litter: YES / NO	Type of Entrance:
Pattern of Cave: (maze/horizontal/pit/dendritic/single passage/other (circle those that apply))	Azimuth of Entrance (looking out. eg., North facing entrance)
Vertical Relief:	Number of Entrances:
Number of Levels:	
Water Elements:	Cave Map (Yes or No):
Hazards:	Special Equipment Needed:
Special Skills Required:	Type of Protection Needed:
Cave Contents:	Geologic Formation:
Rock Type	Type of Cave:
Categories of Significance satisfied: Geological, biological, scientific, archeological, historical, cultural and educational values: See below	Photos of Entrance and Representative Passages:
Research: References to research done in the cave	restrictions on information dispersal
Cave History if Known:	

Additional Comments:

Recreation Value (visitors? register?):	Hydrological Resources Lakes, rivers, other substantial amounts of water? Seasonal freezing or flooding cycles of entering and exiting water levels?
Biological Resources: Evidence of bat use: Evidence of other animal use: Observations of invertebrates: Naturally introduced organic material: (roots, fungal, lichen, moss, or algal growths):	Safety / Hazards: Hypothermia: Toxic gases: Flooding: Drop-offs, unstable entrances, cave interiors, rocks, etc. Diseases, Poisonous animals:
Geological Resources Passage or features which display geological events not exposed at the surface (e.g., preserved lava flows, exposed faults, etc.) Secondary mineral deposits Unconsolidated sediments (e.g., pristine mud or silt floors)	Cultural / Paleontological Resources Artifacts which have been left in the cave 50 years or more (includes Historic graffiti) Natural objects (e.g., logs, rocks, etc.) which were brought into the cave at least 50 years ago. Human-caused alterations to the cave which are at least 50 years old

Recommendations for Cave and Karst Management

Re-solutional features (e.g., scallops, box work, etc.) Cave climate and air flow Aesthetics	Fossils embedded in rock Animal remains (bones, middens, scat, etc.) Sediment deposits rich in pollen
--	---

Management Recommendations/comments: _____

Appendix F – Cave Management Tools and Techniques

F.1 Managing and Monitoring Elements

Below are managing and monitoring elements that are useful in determining the cave's management practices. Monitoring items are accumulated on caves as resources become available. Experienced volunteers are encouraged to participate in data collection, maintenance, and inventory.

Managing elements include:

- Visitor Registers
- Conservation Messages and Interpretive Signs
- Brochures and Handouts
- Cave Maps
- Cave Gates
- Cave Trails
- Access Authorization and Group Size Limits
- Guides or Trip Leaders
- Seasonal and Sensitive Area Closures
- Road Closures, Upgrading and New Construction
- Restrict Information Dispersal
- Take No Action
- Active Management and Restricted Access and Closed Caves (Class 3 & 4 Caves)

Monitoring elements include:

- Photo Transects (photo monitoring)
- Impact Mapping
- Wildlife Monitoring
- Cave Climate Monitoring
- Hydrological Monitoring
- Air Quality Monitoring

Visitor Registers

Registers are a simple and relatively effective technique of determining visitation to all classes of caves. Visitor registers consist of a notebook contained within a biologically inert and weatherproof container. Visitor register data may be validated using a trail counter or similar electronic device if more accurate information is required. For estimation purposes 80% sign-in is assumed for most registers and less sign-in is assumed for heavily visited caves.

Conservation Messages and Interpretive Signs

Conservation messages can be placed within visitor registers, at appropriate locations, or where use of signs would affect the cave's management objectives.

Signs may be installed near the entrance or within caves to increase visitor appreciation of cave resources and/or suggest appropriate caving techniques which will foster visitor safety and resource protection. Over-use of signs should be avoided so as not to interfere with the natural appearance of the cave.

Brochures and Handouts

Handouts for “Developed Natural” and “Natural” caves could be distributed to persons with specific information requests. Handouts for “Primitive” and “Sensitive and Pristine” caves could be given out with cave use access authorization should visitation need to be regulated. Brochures and handouts would reference caving ethics and hazards for specific caves.

Cave Maps

Detailed cave maps may be necessary for other techniques of monitoring such as photo transects and impact mapping. A useful scale for cave maps used for monitoring is 1" = 20'.

Cave Gates

Gates may be used to control access to certain caves (FSM 2356.2 [5]). Cave gates may be required to protect sensitive resources and maintain or change the cave management Class. Gates detract from the entrance area of a cave. If it is determined a gate is required, the gate will be designed and installed to allow free passage of bats, small animals, air, and water into or out of the cave. Gates will be constructed using the best designs available and located for maximum wildlife acceptance and maintain original airflow levels to the cave.

Seasonal closure of caves for the protection of hibernating bats or bat maternity sites will be used as appropriate and closure dates will be determined by the Forest Service Wildlife Biologist.

A Closure Order by the Forest Supervisor is necessary prior to the installation of a cave gate (FSM 2356.1, 2356.2 [4][5], 2356.31). At a minimum, an interim cave management plan is needed. However, a cave management plan is preferred. An access authorization system to enter beyond the cave's gate when the closure is in effect. An example of an access authorization not being needed would be a seasonal closure for bats (maternity or hibernaculum) and the gate is open during the rest of the year.

Cave Trails

Development of cave trails may be used to protect fragile resources. Cave trails can be used to restrict damage to pristine floor surfaces or fragile non-renewable deposits (e.g. bones). Cave trails should be visible, easy to follow, and define the boundaries of all sides of the path. Examples of cave trail markers currently in use include rocks, plastic flagging strung between short PVC stakes, and reflective tape on small plastic or aluminum stakes lining both sides of a trail. Common to all of these methods is that they be all non-corrosive in high humidity.

Access Authorization and Group Size Limits

Access authorizations, trips, and group Size limits are primarily set to promote safety, prevent resource damage and maintain management objectives. Access authorizations limit the frequency of use, and the number of people who can use the cave at one time. Group size limits are required where large groups would have difficulty moving through areas with fragile cave resources without causing damage. The recommended minimum group size is two persons for safety reasons. Usually, only one group at a time should receive access authorizations.

Guides or Trip Leaders

Guides or trip leaders can be used to ensure that proper protocols are followed, limit access and/or use, and/or educate users about caves. A guide system for an un-gated cave could lead to increased public visitation. Outfitter guide permits will be considered carefully before issuing.

Seasonal and Sensitive Area Closures

Some caves may be closed seasonally to protect visitors from seasonal hazards (e.g., flooding) or conserve sensitive wildlife habitat (e.g., bat maternity or hibernacula areas).

Road Closures, Upgrading and New Construction

Roads which lead to, or pass near, a cave's entrance will be considered for closure if closure of the road would help to protect fragile resources, maintain the cave's management objectives, or address safety concerns when there is a cave roof close to the ground surface. Careful evaluation of construction or upgrading of roads leading to or very near a cave will be required to maintain safety to individuals and equipment, and to protect the natural setting of the cave.

Restrict Dispersal of Information

Restricting the dispersal of information is accomplished at multiple levels. Sensitive areas may be best protected by maintaining strict control of information regarding location and what resources are present.

Take No Action

Taking no action is the most common method of cave management. Until a need is determined, leaving the cave in its natural state is the recognized best practice.

Active Management, Restricted Access and Closed Caves (Class 3 & 4 Caves)

Active Management and Restrictive Access and Closed Caves are considered unsuitable for exploration by the general public either because of their pristine condition, unique resources, or extreme safety hazards. These caves will be managed to minimize impacts, and ensure public safety through the utilization of cave management techniques. These are caves which have had closure orders implemented to support restrictive management techniques. A management plan will be required for these caves. Monitoring schedules will be determined, and public participation from the caving community and other appropriate organizations will be encouraged in the assessment to determine the most suitable and effective protective management techniques, such as seasonal closures, access authorization and/ or gates.

Photo Transects (photo monitoring)

Most vulnerable or indicator resources within caves are photographed periodically to determine if they are being impacted. The photos are dated and numbered. The point of view and direction for each photo should be located on a map of the cave.

Impact Mapping

Impact mapping is done to identify and monitor impacts and changes to sensitive resources by natural events and processes, as well as human visitation and use. Two types of impact mapping can be used:

- 1) Fragile resources and impacts are located and described on a map of the cave.

- 2) Areas of the cave's floor and ceiling which are impacted and non-impacted. These maps can be periodically reviewed to determine if resources are disappearing or impacted areas are increasing in extent.

Both types of impact maps can be generated using a detailed map of the cave.

Wildlife Monitoring

Methods to determine periods of wildlife use, type of wildlife use and numbers of individuals will be established where warranted. In particular, sites used by bats for hibernation or maternity roosting should be monitored in order to ensure that the timing of closures is appropriate. Wildlife monitoring must not negatively impact cave resources and/or animals, and is coordinated through a Forest Wildlife Biologist.

Cave Climate Monitoring

Temperature, humidity, evaporation rate, and air flow can be critical to wildlife use, mineral growth, and the preservation of artifacts. The cave climate is monitored where it is suspected that human activities might alter the temperature, humidity and evaporation, and/or overall climate. Activities likely to affect cave climate include gating, blocking or enlarging the entrance, operating machinery within the cave, altering water flow through the cave, or excessive visitation.

Hydrological Monitoring

Monitoring of water flow or water levels within caves may be developed if this information is important to visitor safety, maintenance of flow rates, critical mineral growth, or wildlife. Water quality within caves may be monitored if contamination is likely. Baseline data should be established.

Air Quality Monitoring

CO₂, methane, and other life-threatening gases are known to be present at dangerous levels within some Forest caves. If a problem is identified air quality monitoring will be considered.

F.2 Active and Non-Active Management Considerations

The goal is to appropriately manage caves based on each cave's Class and Values. Several considerations exist that effect **Active** or **Non-Active Management**. Most caves should be in the Non-Active Management category. Management status can change as additional information is acquired on the resource, and the surrounding area.

Pre-planning is a goal of the management process. In many cases, concerns can be addressed using Non-Active Management, and a particular cave can remain in this category until an event or activity warrants that the cave be changed to an Active Management status.

The question "Is the cave commonly known?" is in constant consideration, and affects in part, whether the cave is placed under Active management or Non-Active Management. This is because the better-known caves are more likely to be under Active Management due to the impacts of visitation and abuse.

Active Management Considerations

Active Management Includes:

- Gated caves (various reasons, requires access authorization); have individual management plans, closure orders

- Closed caves, no gates (various reasons, require access authorization) various reasons, individual management plans, closure orders; includes seasonal closures
- Active threats to the cave or its resources; e.g., vandalism, commercial surface activity, high visitation levels
- **Directed Access Caves** and caves in common knowledge to the general public includes web postings
- Caves being used for commercial use (e.g., eco-tours, school education)
- Caves with large numbers of visitors
- Caves with easy access
- Project activity (e.g., science, restoration, nearby surface threats; i.e. Road building, logging, mining, etc.)
- Caves that are getting individual management plans developed or updated
- Caves being monitored

Active Management Caves

Directed Access Caves – CLASS 1

Information on Directed Access Caves is often available through the greeting personnel at the Forest and District offices.

These are caves with relatively easy public access and are undeveloped, but are suitable for exploration by persons who are properly prepared. In general, these caves contain resources that resist degradation by moderate levels of recreational use. General public visitation may be significant. Cave management plans and regular monitoring are required. An access authorization is not required for entry when the cave is managed as a Directed Access cave.

Directed Access caves are caves with open public access that are managed for high impact public use. Management may extend to interpretive information directed towards enhancing public awareness of cave environments and caving ethics. The caves may or may not have sensitive resources that are protected and managed.

Some passages in the caves may be in poor condition as a result of high visitation rates. Caves are typically minimally developed to allow visitors a relatively safe and informative visit, while not detracting greatly from the natural character of the cave. Examples include: trails, steps, and barriers that use native materials, enlarged passages, and interpretive and directional signs. Brochures containing educational and interpretive information may also be available. There may be opportunities for visitors to experience some risk and challenge while encountering natural obstacles (such as uneven floor surfaces and low ceilings), though no special caving equipment is required. Arrangements may be made for a host or guide, and there may be lights and helmets to loan to visitors, or visitors may provide their own necessary equipment for safe exploration. Social interactions are typically between family or educational groups, and social encounters with other groups are common. The character of the cave's natural state is maintained (or restored) to provide maximum interpretation and educational benefits. A parking lot, trail to the cave, and toilets may be available on the surface.

Active Management Caves (CLASS 3 and Class 4)

For Active Management Caves, in general, most of the cave resources are in a good or better condition. These are caves that are in common knowledge, but are visited by more physically-fit persons do to the more strenuous aspects of traversing the cave, or a more strenuous approach to the cave entrance. The caves may be more physically challenging. The caves are undeveloped but are suitable for exploration by persons who are properly prepared. In general, these caves contain resources that resist degradation by moderate levels of conservation conscious, recreational use. Public attention will not be directed toward these caves. They will neither be shown on maps nor discussed in brochures or publications intended for general public distribution. An access authorization will be required for entry. These authorizations will be issued by the Forest Service and all records will be maintained and managed by the Forest Service.

Caves in this group are not developed. Visitors must provide all necessary equipment required for safe exploration. Obstacles usually do not require technical skills such as rock climbing or use of ropes and/or vertical gear. Visitor registers may be used to monitor visitation and concise interpretive signs may be placed near the cave entrance. Trail markers and monitoring instruments will be used only when needed to preserve fragile resources or warn of hazardous conditions. In general, the cave should be kept in a condition that is as natural as possible. Social interactions typically occur among small groups of families or friends, and the chances of encountering other such groups are moderate. Use by experienced recreational cavers will normally represent a minor portion of total visitation. A parking lot and trail to the cave may be available on the surface.

Active Management caves may be closed by order of the Forest Supervisor (FSM 2356.1, 2356.2 [4], 2356.31) and entry may be allowed by access authorization only. A sign at the entrance of such caves will designate it as closed to visitation without an authorization, and indicate the website, office address and phone number where access authorization information may be obtained. A carrying capacity will be established for each Active Management and Non-Active Management cave (FSM 2356.1), and allowable uses determined. Access authorization will be issued only for uses compatible with long-term preservation and protection of cave resources. Except in unusual circumstances, the maximum party size for any group accessing active cave will be six (6) persons. For safety reasons, the minimum party allowed access will be two (2) people. A maximum number of visits per month and per year may be established. Each district will be responsible for issuance of access authorization for caves under their jurisdiction. (A copy of the USDA Forest Service Cave Entry Access Authorization may be found in [Appendix H - CAVE ENTRY AUTHORIZATION EXAMPLE](#))

Non-Active Management Considerations

Non-Active Management – Lesser Known Caves (majority of caves)

Information on and access to Lesser-Known Caves is primarily through the Forest or District officer responsible for caves. Additional support and information may be available through caving organizations in coordination with USFS personnel.

- Remote caves with little visitation
- Not commonly known caves
- Open caves with few safety or conservation issues for those who are properly equipped
- Caves and resources that are not particularly sensitive (FCRPA resource areas)
- Most caves not requiring any access authorization.

Non-Active Management Caves (CLASS 2)

Resources are generally in a good or better condition. Caves in this group are not developed. Visitors must provide all necessary equipment required to safely explore the cave. Technical skills (such as rock climbing) may be required. Visitors must be self-sufficient and have ample caving skills, as the level of risk is significantly higher. Visitor registers with conservation messages may be installed near the entrance, but other management devices will not be installed unless their use is warranted by the presence of fragile resources or extreme hazards. Social interactions are usually between members of a small group of experienced recreational cavers. Social encounters with other groups are very rare because visitation is very low or regulated.

These caves have limited management. In general, these caves contain resources that resist degradation by recreational use. Management will not include restrictive management techniques. Monitoring may be repeated on a five-year cycle unless a more intensive monitoring program is warranted, based on visitation or resources. Resource identification, monitoring, management recommendations, and decisions may be documented in a file created for each of these caves.

Preserve Caves (CLASS 4) - (Sensitive and Pristine Caves)

Restricted Access and Closed Caves may be in either the Active or Non-Active Management areas. A consideration is how well is the cave known?

Resources show no or very little alteration caused by human activity. Most, or all, of the formations are intact and/or in pristine condition. Introduced dust and mud is limited to established travel routes. Travel has been limited to reduce impacts to the floor and other surfaces. Caves in this group are not developed, but may contain markers put in place by conservation-minded cavers to alert others to areas requiring extra caution. Visitors must provide all necessary equipment required for safe exploration. Technical skills (such as rock climbing) may be required, and there is usually an opportunity to experience risk and self-sufficiency. Social interactions are typically between members of a small group of experienced cavers. Visitor encounters with other groups are very rare because visitation is low or regulated.

Sensitive and Pristine Caves by virtue of their high resources, recreational values, hazardous conditions, or combination thereof, require a unique management plan. These caves require monitoring and management to mitigate resource impact. Management may include restrictive management techniques such as gates, access authorization, or seasonal closures. Monitoring will be repeated on a one-year cycle unless a more (or less) intensive monitoring program is warranted based on visitation or resource value. A management plan will be required for this group.

Restrictive access, access authorization, seasonal closures, and other management methods may be used. Access may be granted by a access authorization issued by the Forest Service.

Appendix G - Individual Cave Management Files

There are two files that are kept on individual caves on the Forest; the Master File and the Public File.

The **Master File** contains the complete information on the cave. It is controlled by the authorized Forest or District line officer (cave resource person). The Master File contains FOIA exempt, research-related, sensitive information, the Cave Management Plan, and other information.

The **Public File** contains management information as it relates to the public. This information will vary depending on the determinations made by the line officer.

Public File information for caves may be available at the Forest or District front desks. All other cave related information is available through the Forest or District line officer.

MASTER FILE

The Master File will be maintained under the control of the Forest or District line officer. Access to the Master file is strictly through approval of the line officer. Signed MOUs, cost-share agreements, and/or Non-Disclosure Agreements (NDAs) will help the line officer in determining file access and information distribution.

Information detailing locations, maps, sensitive resource values, and monitoring records will be kept separate from the public information files on cave management. Use of sensitive information files will normally be restricted to Forest personnel dealing directly with cave management, and provided to interested individuals and organizations, such as caving groups, scientists, and recreationists, who have interests in managing the cave resources. Other access to sensitive files will be approved by the Forest Supervisor, District Ranger, and Resource Specialist responsible for caves, as needed and on a case-by-case basis. Information contained within cave files is not subject to standard USFS records retention policies.

The Master File should contain the following information and data when available:

- 1) Introduction (Background and natural history)
 - A) When found, by whom, other people present, how it was located, history of naming.
 - B) Significant cave nomination form and findings/status of nomination including cave number, confidential records.
- 2) Identification of cave location
 - A) Topographic map location, survey map (plan view), and vertical section. Global Positioning System (GPS) coordinates or other detailed directions for reaching the cave entrance such as: road log by tenths of a mile, walking distance both horizontal and vertical, approximate walking time at an average pace from the parking area, pedometer log, and step log.
- 3) Resource identification and evaluation
 - A) Detailed description of major features of the cave, including speleothems, fauna, flora, biological, hydrological, geological, archaeological, paleontological, etc.
- 4) Hazards
 - A) Detailed description of the hazards present within the cave and/or at the cave entrance. Include recommended equipment and procedure for reaching, entering, and exploring the cave.
- 5) Management Category. Classification and Cave number designation
- 6) Priority level including whether Active or Non-Active management is needed
- 7) Initial management.

- 8) Monitoring (including LAC's)
- 9) Management adjustment using LAC guidelines
- 10) Pictures
 - A) Showing the entrance to the cave, the major areas and features of the cave. The individual who took the pictures and when taken should be marked on the pictures.
- 11) Trip Reports
- 12) Miscellaneous (rescue plan, special restrictions, etc.)
- 13) Entry Authorization if any.
- 14) Cave Management Plan
 - A) The Cave Management Plan should contain:
 - Cave Name
 - Goals and objectives
 - Location/setting - if management plan allows
 - Administrative and Background information:
 - Administrative actions
 - Closure Orders (open, closed, seasonally open, only parts of the cave open, etc.)
 - Withdrawals,
 - Cave access authorization requirements (number of trips limit, group limit size, key distribution, deposit and return procedures
 - Restrictions, etc.
 - Description of resources
 - Identification of issues
 - Management prescriptions/recommendations
 - Maps
 - Monitoring element
 - Safety/Emergency Rescue plan
 - Research - data trends
 - Photos that document critical planning elements
 - B) The Cave Management Plan **should not** contain:
 - Directions to the Cave, location or GPS information if the cave is in Class 2, 3, 4, and 5.
 - Sensitive information

PUBLIC FILE

The Public File should contain non-sensitive cave information from the cave's management Plan. Only the location of Generally Known Caves and "Directed Access Caves" will be available to the public.

For **Directed Access Caves** this includes:

- Cave Name
- Cave Access Status (opened, closed, seasonally open, only parts of the cave being open, etc.)
- A current copy of any closure order (biology, vandalism)
- If gated, key distribution and return policy, including deposit if required.
- Group limit size if any (LAC determined).

Recommendations for Cave and Karst Management

- Trip frequency limit if any (LAC determined). For example, access authorization for up to 3 trips per calendar month.
- Equipment necessary for safe exploration (for example vertical caves), and whether equipment inspection is needed prior to the trip.
- List of “areas to be aware of.” For example, List of safety and conservation items that are needed for which the explorer should be aware. (e.g., “Do not disturb any bats.”, “Stay out of the water.”, and “Do not touch formations.”)
- Cave’s History if known.

Note - Directions and location information is confidential and cannot be provided to the public or included in FOIA packages if the cave is in CLASS 2, 3, 4 or 5.

**UNITED STATES DEPARTMENT OF AGRICULTURE
COCONINO NATIONAL FOREST
Appendix H – CAVE ENTRY AUTHORIZATION EXAMPLE**

After authorization is signed by ALL participants, permission is granted to enter the following cave on the date specified.

Cave Name & Number	Date(s) of entry	Key #	Issued by
--------------------	------------------	-------	-----------

The group leader will accompany the group at all times, will assume full responsibility for the actions of the group, and is responsible for the timely return (two working days) of the cave access authorization, gate key, and any other issued materials.

Your signature indicates you have read, understand, and agree to all conditions of this authorization. Trip Leaders must be 18 years old minimum.

1.	Trip Leader Signature	Age	Complete Mailing Address
	Print Name		Phone Number / email
2.	Signature	Age	Complete Mailing Address
	Print Name		Phone Number / email
3.	Signature	Age	Complete Mailing Address
	Print Name		Phone Number / email
4.	Signature	Age	Complete Mailing Address
	Print Name		Phone Number / email
5.	Signature	Age	Complete Mailing Address
	Print Name		Phone Number / email
6.	Signature	Age	Complete Mailing Address
	Print Name		Phone Number / email

This authorizes the permittees to enter and explore the specified cave. Removal of any materials, rocks, or artifacts from the caves and digging or other surface disturbing activities are prohibited. Persons signing this permit accept responsibility for informing themselves of the inherent dangers of exploring undeveloped caves, and accept full responsibility for their conduct and personal safety. The permittees shall hold harmless and forever discharge the Federal Government and its employees of and from any and all claims, demands, lawsuits, damages, and liabilities. The Federal Government assumes no responsibility for any mental or physical injury or damages resulting from entering or exploring the above cave. This is a wild cave with no development.

Recommendations for Cave and Karst Management

CONDITIONS OF THIS PERMIT:

1. This permit is valid only on the date(s) specified for cave entry.
2. This permit and cave gate key must be returned to the Forest Service even if your trip is canceled. Permit and key must be received and/or mailed within two working days of your **scheduled** trip.
3. The permittee copy of this permit must be in your possession while visiting the cave. All party members must sign their names, provide a phone number and address on the **permit** before entering the cave. This permit is valid only for those listed on the permit.
4. **For safety reasons, a minimum number of two (2) people are required to enter a cave.**
5. To reduce resource impact, the maximum number allowed to enter **a cave** at one time is six (6).
6. Smoking in the cave is prohibited.
7. For your safety, please leave the gate key in a safe location just inside the gate, known to all members of your party. The location should be far enough inside the gate entrance such that the keys are out of reach and view from the outside.
8. The trip leader is responsible for keeping the cave locked while exploring the cave, and locking the gate upon exiting.
9. All materials carried into the cave by the group must be removed and properly disposed of. The disposal of any human waste within caves is prohibited. No pets are allowed in the cave. Please remove any litter you find.
10. The permittees are responsible for their own caving equipment. Each member of the group shall have **at least** three (3) separate light sources, one attached to a hard hat with non-elastic chinstrap, and non-skid footwear.
11. In accordance with the Code of Federal Regulations and the Federal Cave **Resources Protection Act of 1988**, removal or destruction of any natural formations, minerals, rocks, biological/wildlife and archaeological resources in or near caves on the National Forest is prohibited.
12. It is agreed that there will be no publicity regarding the specific location of this or any other National Forest cave without written permission from the District Ranger.
13. Use of pictures or any other information secured on this trip is for personal enjoyment only. Commercial or research use will require written approval from the District Ranger.
14. Failure to comply with any of the listed requirements may result in curtailment of future cave access privileges **or in some cases, legal prosecution.**

NOTICE: If you find the gate broken or tampered with, any evidence of forced entry, or if you notice damages to any cave resources, please report the information to the Forest Service. If you find anyone doing damage to a cave, please get all possible information (names, times, vehicle descriptions, license numbers, etc.) and report the incident to the Forest Service as soon as possible.

We hope your trip will be a safe and enjoyable one.

COMMENTS and/or SUGGESTIONS:

Appendix J – Karst Management

Karst is a landscape formed from the dissolution of soluble rocks and is characterized by sinkholes, caves, and underground drainage systems. It is usually associated with limestone, dolomite and gypsiferous rock types.

Karst Management concerns the protection and use of karst systems and individual karst features such as cave entrances with sustainable land use and natural resource management practices. The primary focus is to manage surface and subsurface karst resources by applying appropriate management practices on the surface within the karst environment¹⁴.

The Coconino National Forest has sinking streams, sinkholes and active karst areas. Cave entrances are karst features. Coconino karst management objective is to determine and manage significant karst features with respect to their three-dimensional characteristics, level of connectivity between the surface and subsurface, hydrological characteristics, geological, biological, scientific, archeological, historical, cultural and educational values, recreational and commercial values, variety and abundance, and visual quality.

The primary challenges of karst management are addressing the complex and three-dimensional nature of karst. A specific challenge is to manage the potential for karst hydrological systems to transport water, nutrients, soil, and pollutants into and through underground environments.

The management strategies include but are not limited to buffer zones and siltation reduction activities around karst features, and awareness and consideration of potential impacts when planning and authorizing grazing, timber harvesting, and non-sealed road construction in karst areas.

Karst is a unique, non-renewable resource that has many values. These include:

- Caves, including passages not accessible by humans
 - FCRPA significance criteria (hydrology, archaeology, paleontology, biology, mineralogy, and recreation)
- Biological Values
 - Forest productivity
 - Unique plant and animal habitats
 - Fisheries
- Hydrological Values
 - Water quality
 - Water quantity
- Mineralogical Values
 - Mineral deposits
 - Oil and gas
- Scientific Values
 - Geography/Geology
 - Archaeology/Paleontology
- Cultural Values
 - Traditional Cultural Properties

¹⁴ <https://www.for.gov.bc.ca/hfp/publications/00189/Karst-Mgmt-Handbook-web.pdf>

Recommendations for Cave and Karst Management

- Economic Values
 - Timber
 - Livestock Grazing
 - Recreation
 - Industrial products

In order to protect valuable cave and karst resources, while still allowing surface activities to continue, a variety of management techniques can be used. These may be used in different combinations or individual techniques may be altered to produce a more desirable management.

Key Karst Management Objectives

To promote sustainable forest practices on karst landscapes and achieve the following objectives, while minimizing impacts to timber supply and operational costs:

- Maintain the ability of karst landscapes to regenerate healthy and productive forests after harvesting
- Maintain the surface and subsurface habitats of karst ecosystems to ensure biodiversity
- Maintain the natural flows and water quality of karst hydrologic systems
- Maintain the natural rates of air exchange between the surface and subsurface
- Implement the different levels of karst inventories to determine their relation to karst management (Order 4 to Order 1).
- Reduce soil erosion around and into karst features.
- Reduce sedimentation into karst features.
- Protect significant surface karst features (e.g., sinkholes, sinking streams, springs, cave entrances) and subsurface karst resources (e.g., caves, underground streams, subterranean fauna)
- Provide recreational opportunities where appropriate.

Karst & Volcanic Ecosystem Inventory Levels

NOTE: See also FSM 2880 for geological resource inventories for caves and karst ecosystems. Order 1, 2, 3, and 4 inventories

A key aspect of effective karst management is conducting karst inventories and assessing the vulnerability of the karst. There are three levels of karst inventories. Each level has increasing requirements for data collection and evaluation. They are:

- Reconnaissance
- Planning
- Karst field assessments

Reconnaissance-level

Reconnaissance level karst/volcanic ecosystem inventory maps are not yet completed on the forest. Reconnaissance-level karst inventories are used to identify areas of potential karst development. Reconnaissance level inventory maps should be checked prior to any forest development on potential karst terrain. A recommended scale is 1:250,000. Order 4 Inventory

Planning-level

Planning level inventories are used to delineate karst unit boundaries, and determine the distribution and variation of karst development over a landscape or watershed. They are also used to identify the extent of karst and non-karst catchment areas.

Planning-level inventories are used for landscape-level forest development planning and a guide the location and scope of karst field assessments. This is probably like order 3 or Order 2 inventory, 1:100,000 to 1:24,000 scale.

Karst & Volcanic Ecosystem Field Assessments

Karst Ecosystem Field Assessments focus on evaluating the karst attributes of a relatively small karst area of interest (e.g., timber sale or road). Karst field assessments can be done prior to any road construction or forest harvesting on karst terrain. Typically, they should be done prior to or during site-level planning. Karst features include caves, sinkholes, disappearing streams, and underground drainage systems. Though the soluble bedrock is usually limestone, dolomite, or gypsum, karst features regularly occur on the surface above. The Mogollon Rim region and Colorado Plateau demonstrate many of these features.

All karst is vulnerable.

Karst Field Assessments determine karst vulnerability using a systematic procedure that evaluates three major criteria: epikarst sensitivity, surface karst sensitivity, and subsurface karst potential. Other factors considered for assessing vulnerability include soil texture, and unique or unusual flora/fauna or habitats. These ratings are used to guide appropriate forest management practices for the karst based on the level of vulnerability.

The data from a karst field assessment also identifies “significant” surface karst features where specific protective measures (e.g., buffers) are recommended for forest operations.

Karst field assessments also identify sinking and losing streams/sinking watercourses where special riparian management considerations are recommended.

A karst field assessment can be triggered under the following circumstances:

- An area is underlain by carbonate bedrock.
- A development is proposed on non-carbonate lands located within the contributing drainage basin of known or suspected carbonate units. (In this case, the karst field assessment would be carried out on the known or suspected karst units located downstream of the proposed timber sale.)
- Reconnaissance-level maps indicate that an area may be underlain by karst.
- A planning-level inventory has identified karst polygons with moderate or high vulnerability potential ratings in or around the area.
- There is prior knowledge of karst in or around the area.
- Karst features have been identified in the area.
- Forestry activities, such as salvage, spacing, pruning or commercial thinning are planned on an area known or suspected to be underlain by carbonate bedrock.

The karst field assessment primarily evaluates surface features, but can also include subsurface evaluations if caves are encountered. Karst field assessments examine such things as:

- The location, classification and significance of surface karst features
- Epikarst development and soil thickness
- Density of surface karst features
- Characteristics of streams
- The inspection and mapping of caves
- Subsurface karst potential
- Unique or unusual flora/fauna/habitats
- Geomorphic hazards.

A subset of these assessment categories may be adequate to address the site management needs when caves are not noted.

The data collected during a karst field assessment are used to stratify the karst area of interest.

Management Objectives and Practices for Significant Karst Features

Karst Assessment Criteria

Assessment of the significance of karst features is conducted during a karst field assessment.

Methods and criteria for determining the significance of surface karst features:

- Dimensional characteristics
- Level of connectivity between the surface and subsurface
- Dye tracing
- Hydrological characteristics
- Geological, biological, scientific, archeological, historical, cultural and educational values
- Recreational and commercial values
- Rarity and abundance
- Visual quality.

If the significance of a karst feature is unknown, or has not yet been determined, it is recommended that the feature be treated as significant until a determination can be made.

If caves are encountered determine the significance of the caves using the Cave Management Plan. Significant caves are protected under FCRPA. The significance criteria are summarized by the following:

- Significant hydrological, archaeological, paleontological or cultural values
- Bat hibernacula, maternity colonies, or rare cave-dwelling organisms
- Scientifically important climatological or geomorphological sediments
- Significant recreational opportunities
- Well-developed decorations
- Unique intrinsic values (e.g., large dimensions, unusual configuration, rare/uncommon location).

Since determining the significance of caves requires subsurface inspection and mapping, it should only be done by personnel with specialized knowledge, training and experience. Organizations with experienced individuals and equipment are available and willing to help with this effort.

Significant Karst Feature Protections

Surface disturbance, and the resulting debris and silt being washed into the karst and caves is a primary impact to significant karst features. It is recommended that buffers be established for the following significant karst features:

- Significant cave entrances
- Areas above significant caves (depending on depth using the 45° principle)
- Significant surface karst features
- Significant karst springs
- Unique or unusual karst flora and fauna habitats.

The following current management practices and mitigation activities are recommended within all karst buffers:

- A buffer zone of approximately 300 feet should be established on the perimeter of the karst feature.
- Soil erosion and siltation is a primary concern. Erosion and siltation mitigation measures such as placement of soil barriers and traps to reduce disturbance should be considered.
- Reduced disturbance practices will be used for 1000 feet upstream in the drainages of large karst features.
- The upstream water course buffer will be 100 feet wide.
- No roads or skid trails should be located within karst buffers
- No trees should be felled within karst buffers except to remove safety hazards or reduce significant forest health risks. Where felling is required, consider the following:
 - Use partial cutting.
 - Fall away from karst features.
 - Leave felled timber on the ground to help provide coarse woody debris and an intact forest floor.
 - If felled timber must be removed (e.g., significant forest health concerns) avoid yarding over or through karst features.
- Take measures to ensure that human wastes, petroleum products, herbicides, litter and other pollutants do not contaminate karst buffers by following proper storage, transport and disposal procedures.
- Sinkholes large enough to create their own microclimate should be managed similarly to a significant cave entrance, with a buffer of 300 feet to maintain interior microclimatic conditions.

Surface Management Above Significant Cave Entrances

The following section summarizes the management objectives and current recommended management practices for significant cave entrances. As these are only brief summaries, please check for more detailed information in the Cave Management Plan.

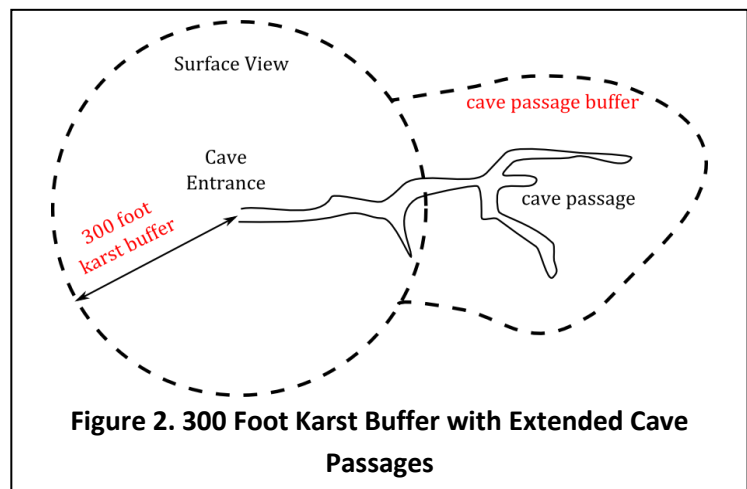
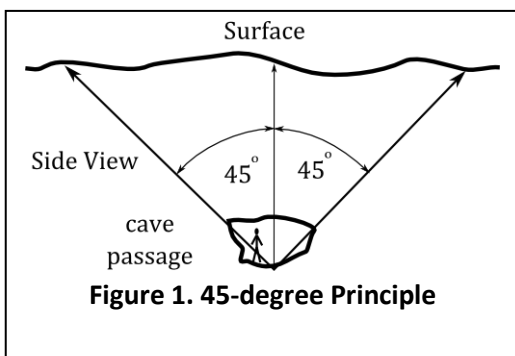
Buffers around cave entrances should achieve the following objectives:

- Leave a minimum 300 foot buffer extending outward from the mouth of the cave entrance. In the case of a significant entrance contained within a sinkhole, the buffer should extend from the top, or outer edge of the sinkhole. Figure 1.

Recommendations for Cave and Karst Management

- Drainages into caves and other karst features should be protected.
- Maintain the microclimate around significant cave entrances
- Maintain stable habitat conditions for any flora or fauna inhabiting the cave entrance or cave
- Prevent logging debris from entering significant cave entrances
- Provide consideration for aesthetics and the recreational experience for visitors.
- Provide a measure of aesthetics/recreational experience for cave entrances with high recreational values.
- Leave understory vegetation along buffer boundaries, and green trees in the opening to help maintain interior microclimatic conditions and inhibit the encroachment of edge species into the buffer.
- For buffers around entrances of caves known to contain bat hibernacula or maternity colonies, or threatened or endangered species, follow the recommendations in the Endangered Species Act of 1973.
- The size of the management area for specialized harvesting practices can be projected to the surface using the 45° principle. Figure 2.
- **Note:** Of particular concern is when karst features are, (or highly likely to) drain into significant caves. When significant caves have karst buffers, these buffers should be expanded (at least considered) to the karst features that are likely to have hydrological connection.

The 45 ° principle is a 45° angle up to the surface above known passages.



Practices recommended for cave entrances that do not meet significant cave criteria include:

- Fall and yard away from the cave entrance as much as possible.

- Remove any slash and debris that falls in or around the cave entrance, provided removal does not cause further disturbance.
- Retain non-merchantable trees, advanced regeneration, wildlife trees, and other vegetation within the management zone.
- Reduce ground disturbance

Riparian Management for Sinking / Losing Streams & Sinking Watercourses

On karst terrain, surface streams that do not sink or lose water to the subsurface can be managed using the default standards for riparian management as specified by the U.S. Fish & Wildlife Service. Streams/watercourses that sink or lose water to the subsurface may require special riparian management considerations, as they have the potential to transport sediment and debris into sensitive subsurface karst environments.

Management Objectives

- Maintain water quality and quantity
- Limit the introduction of sediment, fine organic material or woody debris into subsurface environments within the range of natural conditions.
- Include Forest riparian management objectives.

Management Practices and Mitigation Activities

- Reduce sediment, organic material and woody debris that can be transported downstream, accumulate and clog karst features.
- Reduce the introduction of fine sediment and organic material into subsurface cavities and caves.
- Retain trees with roots embedded in the watercourse edge.
- Fall and yard away from the watercourse to the fullest extent possible.
- Avoid yarding across the watercourse.
- Remove slash and debris that inadvertently enters the watercourse.
- Retain trees and other vegetation (understory, shrubs, herbs) within the watercourse buffer.

These recommended practices, or others deemed appropriate to achieve the management objectives, should be applied for a minimum of 1000 feet upstream of the recipient feature, or to the point where the watercourse is no longer readily identifiable.

Many sinking and losing streams can spend a large part of the year as a dry stream channel, only flowing when the subsurface karst system backs up and/or during major storms or runoff events. When these types of streams flow, they can be major contributors of sediment, organic material and other debris that are readily transported underground.

Karst Management Practices for Grazing

Cave/Karst Description for Grazing: The allotment is located in karst terrain, a landform that is characterized by underground drainage through solutionally enlarged conduits that may contain sinkholes, sinking streams, caves, and springs. Sinkholes leading to underground drainages and voids are common.

These karst features, as well as, occasional fissures and discontinuities in the bedrock, provide the primary sources for rapid recharge of regional groundwater aquifers.

Sinkholes and cave entrances collect water and can accumulate richer organic materials and soils. This, in conjunction with the more stable microclimate near a cave entrance, supports a greater diversity and density of plant life which provides habitat for a greater diversity and density of wildlife.

The caves also provide habitat for a number of animal species. Cave entrances support communities of raptors, rodents, mammals, and reptiles, while the interior of the caves may support a large variety of troglobitic, or cave-dependent, species. The troglobitic species have adapted to the cave environment which has a constant temperature, constant high humidity, and total darkness. Some of the caves in the area contain easily disturbed bat colonies.

Many of the caves in this area contain fragile and very delicate speleothems such as stalactites, aragonite and gypsum crystals, and speleogens. Cave passages or karst drainage may exist very close to the surface creating the possibility for slow subsidence or sudden collapse.

Grazing Impacts on Caves and Karst: Cattle grazing in karst areas, particularly near sinking streams or springs, can cause a great increase in the turbidity and type of organic materials carried into a cave system. Large increases in the manure content and other materials entering the cave ecosystem due to livestock can cause a deterioration of the water quality by changing the nutrient value and pH of the water, thus becoming harmful to the wildlife in the cave. It can also pose a health threat to any human visitors to the cave.

Grazing Mitigations: Range improvements such as **fencing** off fragile recharge sites and riparian areas can help reduce the impacts to these sensitive zones. Drinking troughs and salt licks can be placed away from recharge areas and springs outside the fenced off area. Size guidelines for buffers are listed in [Riparian Management for Sinking and Losing Streams/Sinking Watercourses](#) above.

Karst Management Practices for Road Construction

There are four areas of road construction and maintenance in karst areas for native surface roads. Paved surface roads have additional requirements. For non-sealed roads, the karst management practices are:

- Locating roads, landings and quarries
- Constructing roads, landings and quarries
- Maintaining roads
- Deactivating and rehabilitating roads.

Road Location in Karst Terrain

A major area of potential conflict with road locations is the fact that logging roads are often located along ridges and areas of higher elevation to achieve easier access to timber and maximum deflection for harvesting. There are two issues – the need to protect exposed epikarst and the need for efficient access to timber. The following mitigation activities are recommended:

- Use existing roads, landings and quarries wherever possible.

Recommendations for Cave and Karst Management

- Avoid locating roads over sinking streams. These streams may be intermittent and only active during rain events or snow runoff.
- Locate quarries on a site-specific basis while accounting for the nature of karst resources in the area.
- Locate roads and landings to minimize deep cuts and fills.
- Locate roads, landings and quarries to maintain natural surface drainage patterns as much as possible.
- Avoid locating roads, landings, quarries, spoil sites and/or equipment turnaround/turnout sites within karst and cave buffer zones.
- Avoid facilitating public access to sensitive or hazardous karst areas.
- Locate storage areas for fuel and other hazardous materials off karst terrain.

Road Construction, Landings and Quarries

The following mitigation activities are recommended:

- Flag karst features within/near the operating area.
- Modify or cease operations if previously unidentified karst features or values are encountered during road, landing or quarry construction, and notify the Forest Service district office.
- Avoid construction activities during periods of heavy rainfall.
- Avoid importing ballast from non-karst terrain.
- Stabilize disturbed areas, such as quarries, to reduce erosion potential.

If road location within the Karst Buffer Zone is unavoidable, these mitigation activities should be employed:

- Directionally fall and yard right-of-way trees away from roadside karst features.
- Pile surplus construction material away from surface karst features, and streams leading into features.
- Avoid drilling or blasting near karst features, or if this is not possible, use mitigative strategies such as delayed charges, blasting mats, etc.
- Use overlanding road construction methods near roadside karst features.
- Avoid fueling or servicing machinery near surface karst features and cave entrances.
- Keep the wheels or tracks of equipment away from roadside karst features. If not possible, keep wheels or tracks parallel to the edge of features.
- Avoid removing gravel or fill from roadside depression features.
- Minimize clearing of roadside vegetation.
- Use sediment traps and vegetated infiltration areas to prevent road runoff entering exposed epikarst, surface karst features, cave entrances or sinking streams.
- Complete construction activities so that cut and fill slopes have time to revegetate before the wetter months of the year.
- Reduce road runoff by leaving roads on exposed carbonate bedrock unsealed. Use geotextile materials if sedimentation of groundwater is a potential hazard.
- Direct runoff from bridge decks away from stream channels and into vegetated cover along stream banks.

- Minimize potential sedimentation problems by using geotextile materials on bridge decks and around bridge ends.
- Avoid the use of chemically treated wood for bridges.

Maintaining Roads

The mitigating activities for road maintenance are:

- Maintain silt/sediment traps and drains to function properly, and dispose of accumulated debris away from karst features and watercourses leading to features.
- Minimize accumulations of graded materials along roadsides where sediment could enter features or watercourses leading to features.
- Avoid the use of chemical dust suppressants, de-icing agents and salt.
- Locate storage areas for fuel and other hazardous materials off karst terrain or at least on low vulnerability karst areas (except for daily fuel requirements).
- Avoid fueling or servicing machinery near surface karst features and cave entrances

Road Deactivation and Rehabilitation

The following mitigation activities are recommended:

- Use strategies to prevent sedimentation when permanently deactivating roads (e.g., armoring drainage ditches).
- Do not use quarries as storage sites for logging debris/wood waste, refuse, petroleum products, etc.
- Deactivate quarries upon completion of operations.
- Take measures to make deactivated quarries inaccessible to the public (e.g., berms, water bars).
- Restore natural surface drainage patterns as much as possible to maintain the quantity and quality of subsurface flows.
- Avoid road rehabilitation during sustained or heavy rainfall.
- Avoid road deactivation or rehabilitation when disturbances to roadbeds may be detrimental to karst values in the area.
- Keep the wheels or tracks of equipment away from the edge of roadside karst features. If not possible, keep wheels or tracks parallel to the edge of features.
- Avoid introducing soil or bedding materials into karst features.
- Complete rehabilitation operations with sufficient time to allow for adequate revegetation before the wetter months of the year.

Karst Management Practices for Timber Harvesting

Karst inventory levels are defined in [Karst & Volcanic Ecosystem Inventory Levels](#). Karst areas require buffer zones to mitigate the impact to sensitive subsurface aquifer and ecosystem. The guiding sizes of the buffers are:

- Karst areas require buffer zones to mitigate the impact to sensitive subsurface aquifer and ecosystem.
- No roads or skid trails should be located within karst buffers
- No trees should be felled within karst buffers except to remove safety hazards or reduce significant forest health risks. Where felling is required, consider the following:
 - Use partial cutting.

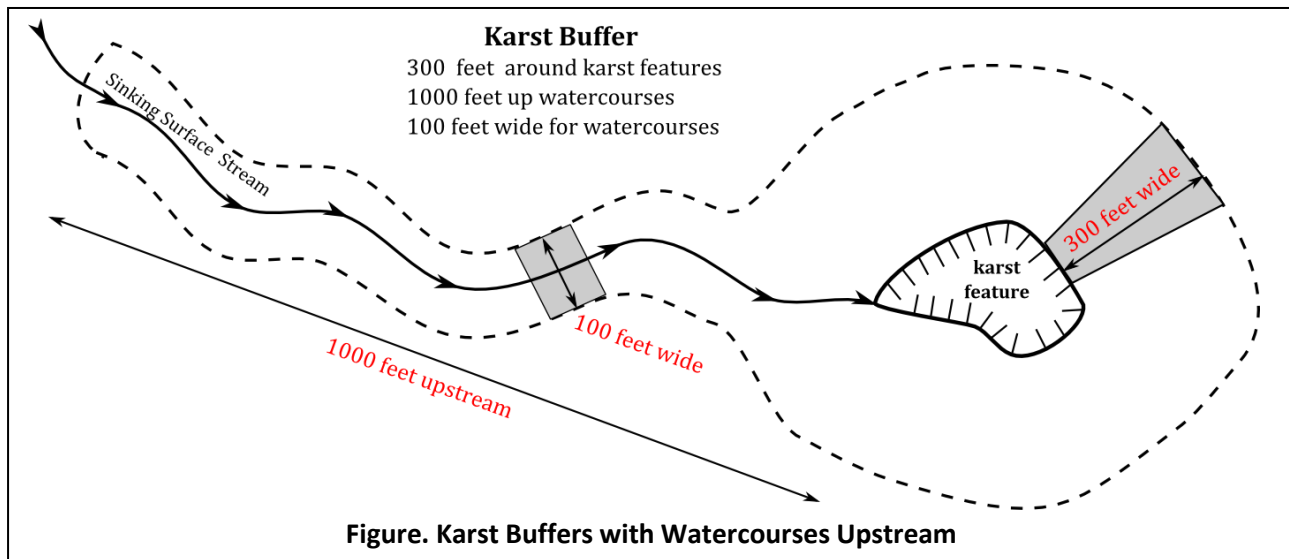
Recommendations for Cave and Karst Management

- Fall timber away from karst features.
- Leave felled timber on the ground to help provide coarse woody debris and an intact forest floor.
- Use contour felling techniques to maximize water, soil, and organic matter retention on slopes.
- If felled timber must be removed (E.g. significant forest health concerns) avoid yarding over or through karst features.
- 300-foot buffer around the upper edges of the karst feature
- 1000-foot buffer upstream for watercourses recharging karst features
- Upstream buffers should be 100 feet wide
- The buffer is extended above significant cave passages

Limited exceptions to this may occur in special situations where some form of site-specific intervention is required to help protect forest or karst resources. These include:

- Forest health issues such as insect infestations
- Thinning for fire protection
- Human health related issues

Timber management activities that may be required on karst areas should be conducted in consultation with a karst specialist, the Forest Hydrologist, and/or other relevant resource agencies.



For

harvesting operations occurring inside of karst areas, the recommended BMPs are:

Karst Topography	Current Management Practices
Karst Mitigation Activities	<ul style="list-style-type: none"> ● 300-foot buffer zones around karst perimeters. ● Water course disturbance reduction methods used 1000 feet up drainage; 100 feet wide. ● The buffer will be extended above significant cave passages. ● Timber felling away from karst features and drainages.

	<ul style="list-style-type: none">• Reduced ground disturbance including:<ul style="list-style-type: none">◦ Skidding through drainages reduced or avoided.• Harvesting equipment to reduce ground disturbance is used. Conduct safety briefings for appropriate personnel.• Flag karst features and/or values within the operating area.• Consider restricting harvesting to periods when the likelihood of heavy rains and high runoff are low.• If previously unidentified karst features or values are encountered, modify or cease operations until the features or values can be assessed. Notify the local Forest Service district office.• Minimize exposing mineral soil as much as possible.• Locate storage areas for fuel and other hazardous materials off karst terrain or at least on low vulnerability karst areas (except for daily fuel requirements).• Keep the wheels or tracks of equipment at least 300 feet from the edge of karst features. If not possible, keep wheels or tracks parallel to the edge of features.• Take appropriate measures to correct inadvertent water diversions to prevent sediment transfer into subsurface environments.• Avoid fueling or servicing machinery near surface karst features and cave entrances. Take appropriate measures if spills occur.• Avoid piling slash on exposed, well-developed epikarst.
--	--

Karst Management Post-Harvest Operations

Post-harvest operations should be modified to accommodate the vulnerability of a karst area. Post-harvest operations include:

- Minimize the impact of herbicides and fertilizers on karst groundwater systems
- Minimize soil disturbance from mechanical activities of site preparation.
- Minimize the impact of burning, particularly on karst with shallow organic soils
- Reforestation
- Minimize the obstruction or clogging of karst features with spacing and pruning debris.
- Monitor BMP and mitigation activity effectiveness.

Karst Catchment / Recharge Area Management

The primary karst catchment management objective is to maintain the water quality and quantity of streams that sink or lose water into downstream karst units.

Karst catchment areas are comprised of all lands contributing surface runoff and/or diffuse recharge to the karst system, including upstream non-karst areas.

Karst catchments are delineated during karst inventories. Dye tracing can be used to determine subsurface flow paths, particularly in cases where a subsurface hydrological connection crosses surface drainage divides.

Glossary - Terms and Definitions

Best Management Practices (BMPs) – Recommended methodologies used to implement the defined goals and objectives.

Cave¹⁵ Any naturally formed void, cavity, recess, or system of interconnected passages which occurs beneath the surface of the earth or within a cliff or ledge, including natural subsurface water and drainage systems, which is large enough to permit a person to enter, whether or not the entrance is naturally formed or manmade. The term "cave" shall also include any natural pit, sinkhole, or other feature, which is an extension or component of a cave.

Cave Life All life forms, including plants and vertebrate or invertebrate animals, and microorganisms endemic to caves or which commonly use caves during the completion of their life cycles.

Cave Resource The cave itself and any material occurring naturally in caves, including sediments, paleontological deposits, minerals, speleothems, water, cave life, and other natural resources.

Caver A person who explores caves as a recreational pursuit. Synonyms: potholer, spelunker.

Code of Federal Regulations (CFR) CFR 36 Part 290 pertains to cave management.

Developed Cave Any cave or cave site that has been developed for the benefit of the public. Developments may include improved access roads, parking areas, sewage and sanitation facilities, trails, safety barriers, interpretive displays, and/or other similar features designed for public use.

District A subdivisions of the Forest; a management area under the jurisdiction of the District Ranger.

Epikarst The upper surface of karst, consisting of a network of intersecting fissures and cavities that collect and transport surface water and nutrients underground; epikarst depth can range from a few inches to tens of feet.

45° Principle A 45° angle up to the surface above known cave passages.

Federal Cave Resources Protection Act of 1988 (FCRPA) - (16 U.S.C. 4301-4309; 102 Stat. 4546)– The act secures, protects, and preserves significant caves on Federal lands for the perpetual use, enjoyment, and benefit of all people

¹⁵ https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5403594.pdf - 2356.05 - Definitions

Forest Service Manual (FSM)	The Manual listing policies by which the Forest Service administers the land.
Gypsiferous	Soils containing gypsum
Hydrological Setting	Consists of all of the natural components of a particular hydrological system, including areas of recharge, drainages, watersheds, regional movement of water through a particular geographical and topographical area, and the related structural components and geological formations through which it moves or by which it is controlled.
Hibernacula	Roosts where bats hibernate during cold winter months.
Indicator Resources	Vulnerable, or fragile resources that are susceptible to impact. Examples include pristine or fragile formations, cultural or paleontological material, water routes through some passages, and biota including bats. Photo transects use indicator resources.
Karst	Karst is a topography formed from the dissolution of soluble rocks such as limestone, dolomite, and gypsum. It is characterized by underground drainage systems with sinkholes and caves. Karst landscapes are characterized by closed depressions, disappearing streams, and solutional shaping. Classical karst drainage is vertical and underground.
Karst Field Assessment (KFA)	(or site level karst inventory and vulnerability assessment). In this process, the major karst attributes are assessed, and include: karst unit boundaries, surface karst features, epikarst sensitivity, surface karst sensitivity, karst roughness, streams and hydrology, subsurface karst potential, and unique or unusual karst flora and fauna.
Level of Acceptable Change (LAC)	A process for determining what changes are “acceptable” considering the use loading on the resource. The LAC process identifies the desired condition of a cave resource, defines the amount of change allowed to occur, and establishes the procedures for monitoring and evaluating management performance.
Pristine Cave	A cave containing resources which have significant values that can be easily damaged, disturbed, or destroyed. Trails causing the least impact possible have been established and maintained. Active, conservation-oriented cave management has been established to reduce damage.

Pseudo Karst	A topography that resembles karst but that is not formed by the dissolution of limestone; usually a rough-surfaced lava field in which the ceilings of lava tubes have collapsed.
Sensitive Cave	A cave containing resources which have significant values that can be easily damaged, disturbed, or destroyed.
Sink, Sinkhole (USA)	General term used for closed (to humans) depressions. They may be basin, funnel, or cylinder shaped.
Speleogen	Relief features on the walls, ceilings, and floor of any cave or lava tube which are part of the surrounding bedrock. Examples of these include but not limited to anastomoses, scallops, meander riches, petromorphs, and rock pendants in solution caves. There are similar features unique to volcanic caves. These all refer to the remaining rock after other parts of the rock has been eroded away.
Speleologist	A scientist engaged in the study and exploration of caves, their environment, and their biota.
Speleothem	Any natural mineral formation or deposit occurring in a cave or lava tube, including but not limited to any stalactite, stalagmite, helictite, cave flower, flowstone, concretion, drapery, rimstone, or formation of clay or mud. These are different types of cave formations.
Wild or Undeveloped Cave	In contrast to a developed cave which lacks formal improvements to facilitate public use. Trails are user-developed or nonexistent; parking, sanitation, and interpretive displays are lacking.

Bibliography

Author Credits

The Recommendations for Cave and Karst Management was originally compiled and written by Ray Keeler (NSS, Central Arizona Grotto). Versions of this document written for Arizona Forest lands are available at the following link.

<http://centralarizonagrotto-cavemanagement.webstarts.com/>

Click on the Cave Management tab for individual Forest cave management Guides.

Significant input has been received from Robert Pape, John (Doug) Powell (USFS, Humboldt-Toiyabe NF), Rich Bohman and Anastasia Rabin. Additional inputs from Sarah Truebe, and representatives from the five National Speleological Society grottos in Arizona have been included. Editorial comments from USFS personnel John Powell and Polly Haessig (Coconino NF), and the National Cave and Karst Research Institute (George Veni, NCKRI Executive Director) has been extremely helpful. There have been other comments received from individuals who have professional experience in Cave and Karst management.

The intent of this document is that it may serve as a good starting point for any Forest to use when generating their own cave management plan.

Ray Keeler – rckeeler@cox.net

Rich Bohman – rbohman5@cox.net

Colorado Cave Survey Acknowledgements

The Colorado Cave Survey (CCS) represents seven NSS Grottos in the state of Colorado. Those Grottos have all contributed a tremendous amount of knowledge and input to steer development of this document. Colorado cavers have been instrumental in tailoring this document to the specific landscape of White River National Forest. Comments and proposed revisions are received daily and will be incorporated where possible. The CCS Chairs would like to thank the Grotto Representatives for working with their membership and supporting the future of caving in Colorado.

In addition to the work of Grotto members and cavers across the state of Colorado; significant input was received from Ray Keeler, Paul Fowler, Donald Davis, Mark Maslyn, Chad Pedigo, and Jennifer Zedalis.

CCS began this project knowing that WRNF is currently undertaking several projects that will help them better understand the forest landscape. It is the goal of the Colorado Cave Survey to proactively assist them in their work, and offer our continued support protecting, studying, and exploring caves.

For more information about The Colorado Cave Survey, please visit coloradocavesurvey.org

Robert McFarland, CCS Chair — robmcfarland@me.com

Jennifer Zedalis, CCS Vice-Chair — jenzedalis@gmail.com

References

U.S. Forest Service Documents

Land and Resource Management Plan for the Coconino National Forest (March 2018)

https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd606737.pdf

Recommendations for Cave and Karst Management

Code of Federal Regulations, Title 36, Chapter II – Forest Service, Department of Agriculture, Part 290 – Cave Resources Management (290.1 – 290.5)

Code of Federal Regulations. Title 36 CFR §290.1 Purpose and scope
<https://www.ecfr.gov/current/title-36/chapter-II/part-290/section-290.1>

Code of Federal Regulations. Title 36 CFR §290.3
<https://www.govinfo.gov/content/pkg/CFR-2002-title36-vol2/html/CFR-2002-title36-vol2-part290.htm>

Code of Federal Regulations. Title 36 CFR §290.3d Specially designated areas.
[https://www.ecfr.gov/current/title-36/chapter-II/part-290#p-290.3\(d\)](https://www.ecfr.gov/current/title-36/chapter-II/part-290#p-290.3(d)) Draft Cave Management Plan for the Sierra

Vista Ranger District Coronado National Forest 1990, unpublished,

Forest Service Manual, FSM 2300 – Recreation, Wilderness, and Related Resource Management
CHAPTER 2350 – Trail, River, and Similar Recreation Opportunities

Forest Service Manual, FSM 2356 – Cave Management, pages 69-77
https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5403594.pdf

Forest Service Manual (FSM 2800) Directive Issuances

2800 - Minerals and Geology

Chapter 2881 – Geologic Resources and Hazards Inventories

Chapter 2882 – Geologic Resources Program Management

Index of Documents

<https://www.fs.usda.gov/im/directives/dughtml/fsm2000.html>

Lincoln National Forest Cave Ecosystem Management Direction, 1995, 45 pages plus appendices

Dixon R., – Tonto National Forest Cave Resource Management Guide, 1991, unpublished

Nieland, J. Strategy for Cave Management XYZ National Forest (Gifford Pinchot NF), USFS Region 6, 1994, unpublished

Powell, John D. Humboldt-Toiyabe National Forest Recommendations for Cave and Karst Management, email 5/26/2020

Soto, Limaris. National Caves and Karst Program Lead, USFS, – Significant Cave Nomination Process, 2022

Soto, Limaris. National Caves and Karst Program Lead, USFS. – Significant Cave Finding/Decision Form, 2022

Tongass National Forest Land and Resource Management Plan, 2008

https://fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5367422.pdf

Coconino National Forest Cave Resource Management Guide, 1992, Bodenhamer, H., – Coconino National Forest Cave Management Policy, 1990, unpublished Coconino National Forest Cave Management Policy, 12

USFS Region 2 Cave Access Registration Form

https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd514725.pdf

Bureau of Land Management Documents

Goodbar, J. Grazing Management on Karst, Carlsbad District, New Mexico

Other Documents

- Burger, Paul. Alpine karst development and speleogenesis in the Lime Creek hydrologic system, Eagle County, Colorado Colorado School of Mines M.E. Thesis.2, 1999
- Kovarik, J. Geologic Management of cave and karst resources on National Forest System Lands 2013 https://scholarcommons.usf.edu/cgi/viewcontent.cgi?article=1013&context=nckms_2013
- Maslyn, R. Mark & Davis, Donald G. Karst Development on the White River Plateau, Colorado The NSS Bulletin - ISSN 1090-6924 / Volume 41 Number 3: 95-101 / July 1979 (A publication of the National Speleological Society)
- Thrailkill, John V. A speleological investigation of Fulford Cave, Eagle County, Colorado University of Colorado M.S. Thesis, 1955
- Veni, George – National Cave and Karst Research Institute (NCKRI) Personal communications
- Jerry Fant (ACCA), Jim Kennedy (BCI), Roy Powers, Jr. (ACCA) William Elliott (MDC), Agency Guide to Cave and Mine Gates 2009 https://www.jamaicancaves.org/appendix_b_BCI.pdf

Online Resources

- Federal Cave Resources Protection Act
<https://www.govinfo.gov/content/pkg/STATUTE-102/pdf/STATUTE-102-Pg4546.pdf>
- Geology Along the Diamond Rim and Adjoining Areas Gila and Navajo Counties, Arizona
https://nmgs.nmt.edu/publications/guidebooks/downloads/13/13_p0123_p0128.pdf
- Karst Inventory Standards and Vulnerability Assessment Procedures for British Columbia, 2003
https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/nr-laws-policy/risc/karst_risc.pdf
- Karst Management Handbook for British Columbia
<https://www.for.gov.bc.ca/hfp/publications/00189/karst-mgmt-handbook-web.pdf>
- Online Karst Management Handbook Training
<https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/managed-resource-features/best-practices-for-karst-management-training-module>
- NEPA Process Summary
https://ftbf.fnal.gov/wp-content/uploads/2015/06/NEPA_Process_Summary.pdf